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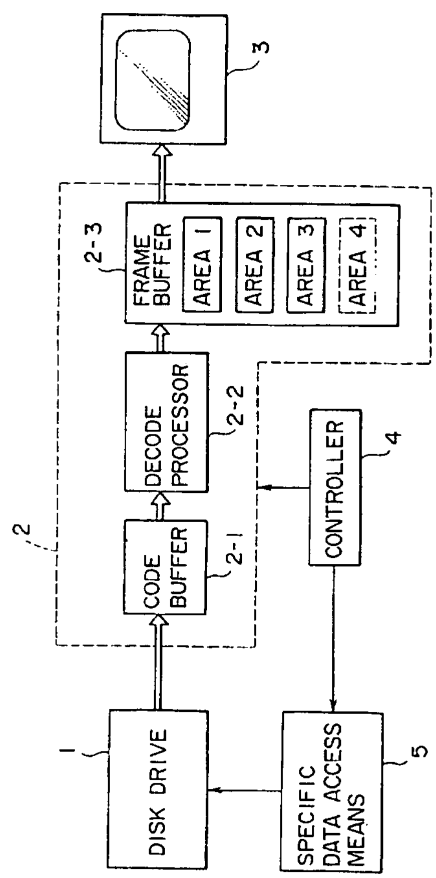
(54) Reproduction of coded data

(57) A coded-data special reproduction method reads out and decodes unit group data composed of intra-frame coded data, inter-frame forward predictive coded data and bidirectionally predictive coded data, writes the decoded data into a frame buffer (2-3) and, after reading out the data therefrom, displays (3) such data. The method comprises the steps of continuously decoding portions of the intra-frame coded data and the inter-frame forward predictive coded data constituting the unit group data read out, while intermittently decoding the remaining coded data; writing the decoded data in the frame buffer (2-3); reading out the data therefrom in a reverse order of the original pictures; and displaying the pictures (3) thus read out. An apparatus designed to carry out the above method comprises a buffer (2-1) for storing the group data; a decoder (2-2) for decoding the coded data obtained from the buffer; and a frame buffer (2-3) for storing the respective coded data decoded by the decoder. Special reverse reproduction of the coded data can be achieved to realize natural reproduced pictures on a display device (3) without the necessity of raising the coded-data transfer rate to the decoder (2-2) or increasing the storage capacity of the frame buffer (2-3).

FIG. 1



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Description

This invention relates to the reproduction of coded data. The invention is particularly (but not exclusively) applicable to special reproduction of coded data stored or sent via communication media or the like or coded video or audio data read out from recording media such as disks. More particularly, but again not exclusively, the invention is applicable to the reverse reproduction of coded data.

In recording media such as digital video disks (hereinafter referred to as DVD), communication media such as LAN (Local Area Network) or broadcasting media such as satellites which are used for processing video and audio signals converted into digital data, it is usual that the data are digitally compressed and coded so that the video and audio signals can be processed efficiently. One of the data compression and coding systems proposed for that purpose is the MPEG (Motion Picture coding Experts Group) system. An exemplary MPEG coder will now be described with reference to Fig. 32.

The MPEG coder is so designed as to perform data compression of a video input signal by executing any one of the following three predictive coding modes, wherein the digitized video input signal is supplied first to a motion detector 101 which detects a motion vector for motion compensative prediction per minimum unit of the motion compensative prediction.

Thereafter predictive coding of the signal is performed in a next predictive coding circuit, wherein one of the following three predictive coding modes is executed to obtain: (1) an intra-frame coded picture (I-picture) by coding the video input signal within a frame; (2) an inter-frame forward predictive coded picture (P-picture) by coding the video input signal only in a forward direction; or (3) a bidirectionally predictive coded picture (B-picture) by coding the video input signal in both forward and backward directions.

More specifically, in a DCT 103 of the predictive coding circuit, the video input signal supplied thereto via a subtracter 102 is processed through discrete cosine transform (DCT) which is a kind of Fourier transform, and a DCT coefficient obtained as a result of such transform is quantized in a quantizer (Q) 104. Subsequently to the quantization, the signal is variable-length coded in a variable-length coder (VLC) 109 where a code of a length different depending on the incidence probability is allocated.

The coded signal thus quantized is dequantized in a dequantizer (IQ) 105, and then is supplied to an inverse DCT (IDCT) 106 where the signal is processed through inverse discrete cosine transform. Subsequently an output of a frame memory predictor 108 is added thereto to consequently reproduce the original video signal. The reproduced video signal is supplied as a prediction signal to the subtracter 102 so as to be subtracted from the input video signal, whereby a difference signal between the input video signal and the prediction signal is outputted from the subtracter 102.

Accordingly the coded signal outputted from the quantizer 104 is a difference signal, and since this difference signal is processed through discrete cosine transform to be thereby quantized, the coded signal is compressed.

The coded signal thus compressed is then supplied to the variable-length coder 109, where entropy coding is executed on the basis of the occurrence frequency deflection, so that the code is further compressed.

Thereafter in a multiplexer 110, the compressed coded signal is multiplexed with the prediction mode data indicative of the I-picture, P-picture or B-picture and the motion vector data. However, since the multiplexed data are generated at an irregular rate, such data are once stored in a buffer 111 and then are outputted therefrom at a fixed code rate.

In order to fix the average code rate, the code quantity may be controlled by changing the quantization scale factor q of the quantizer 104 in accordance with the code quantity stored in the buffer 111.

Fig. 33A shows an exemplary structure of inter-frame prediction obtained among the predictive-coded frames.

A data unit termed a GOP (Group of Pictures) may be composed of, e.g., 15 frames as illustrated in this diagram. In this case, since a random access is necessary in one GOP, at least one frame of an I-picture is required within the GOP, so that there are 1 frame of an I-picture, 4 frames of P-pictures predicted from the temporally preceding I-pictures or P-pictures, and remaining 10 frames of B-pictures predicted from the temporally preceding and succeeding I-pictures or P-pictures. A GOP is a coding unit corresponding to each segment of one sequence of motion pictures.

More specifically, as indicated by arrows in Fig. 33A, an I-picture 1I is coded by intra-frame prediction within that frame alone, a P-picture 4P is coded by inter-frame prediction with reference to the I-picture 1I, a P-picture 7P is coded by inter-frame prediction with reference to the P-picture 4P, a P-picture 10P is coded by inter-frame prediction with reference to the P-picture 7P, and a P-picture 13P is coded by inter-frame prediction with reference to the P-picture 10P. Further, B-pictures 2B and 3B are coded by inter-frame prediction with reference to both of the I-picture 1P and the P-picture 4P, and B-pictures 5B and 6B are coded by inter-frame prediction with reference to both of the P-picture 4P and the P-picture 7P. Similarly, subsequent pictures are coded by such prediction in the manner indicated by arrows.

The numbers of I, P and B represent the ordinal numbers of original pictures.

In decoding the predictive-coded pictures mentioned, the I-picture can be decoded alone since it is predictive-coded within the frame. However, as any P-picture is coded with reference to the temporally preceding I-picture or P-picture, such preceding I-picture or P-picture is required at the decoding time. Similarly, in decod-

ing any B-picture coded with reference to the temporally preceding and succeeding I-pictures or P-pictures, such preceding and succeeding I-pictures or P-pictures are required.

For this reason, the pictures are positionally changed as illustrated in Fig. 33B so that the pictures required at the decoding time can be decoded in advance.

As illustrated in Fig. 34A, such positional changes are so made that the I-picture 1I precedes the B-pictures 1B and 0B since the B-pictures 1B and 0B require the I-picture 1I at the decoding time, and also that the P-picture 4P precedes the B-pictures 2B and 3B since the B-pictures 2B and 3B require the I-picture 1I and the P-picture 4P. Similarly, the pictures are positionally so changed that the P-picture 7P precedes the B-pictures 5B and 6B since the B-pictures 5B and 6B requires the P-pictures 4P and 7P at the decoding time, and also that the P-picture 10P precedes the B-pictures 8B and 9B since the B-pictures 8B and 9B require the P-pictures 7P and 10P at the decoding time. In the same manner, such positional changes are so made that the P-picture 13P precedes the B-pictures 11B and 12B.

The I-, P- and B-pictures thus arranged in the order shown in Fig. 34B are converted into on-medium coded video data in Fig. 34C so as to be recordable on a recording medium such as a DVD. Then the on-medium coded video data are read out therefrom to become decoded video data in the order shown in Fig. 34D. Subsequently, in displaying normal reproduced pictures, the decoded video data are rearranged in the order which is indicated by suffixes in Fig. 34C and corresponds to the original picture order, whereby normal pictures are displayed on a display device.

When displaying special reproduced pictures which are in a reverse direction of reproduction, it is necessary to display the pictures in the reverse order of the original pictures shown in Fig. 34A, as 12B, 11B, 10P, 9B ... and so on. Therefore, in the case of decoding the B-picture 12B for example, since this B-picture 12B is a coded picture predicted from the P-pictures 10P and 13P, these P-pictures 10P and 13P need to be decoded in advance. Further the P-picture 7P is required for obtaining the decoded P-picture 10P, and the P-picture 4P is required for obtaining the P-picture 7P, and the I-picture 1I is required for obtaining the P-picture 4P.

Consequently, even in such reverse reproduction, it is necessary to perform successive operations of first reading out and decoding the I-picture 1I, then decoding the P-picture 4P, subsequently decoding the P-picture 7P and next decoding the P-picture 10P. It is further necessary to decode the P-picture 13P from the P-picture 10P to finally achieve desired decoding of the B-picture 12B from the P-pictures 10P and 13P.

In succession, the B-picture 11B can be decoded from the P-pictures 10P and 13P, and further the P-picture 10P can be immediately outputted since it has already been decoded. However, as the P-picture 7P is required for decoding the B-pictures 9B and 8B, it is necessary to decode the P-picture 7P by reading out the I-picture 1I again and then decoding the P-pictures sequentially.

For reversely reproducing the video data of the MPEG standard in the reverse order of the original pictures, a greater number of decoding steps are needed in comparison with ordinary reproduction and a longer time is required until display of the pictures, so that it is necessary to increase the data transfer rate and so forth to the decoder for shortening the delay time. Furthermore, due to the limited storage capacity of a frame memory, I-and P-pictures need to be decoded so many times.

Therefore, it has been customary in the prior art to solve the above problems by decoding and displaying merely the I-picture in a reverse reproduction mode.

However, when only the I-picture alone is displayed, merely one picture is obtained per 15 frames for example as shown in Fig. 33, and it follows that an extremely reduced number of the pictures are displayed to consequently become unnatural.

First and second aspects of the invention are set forth in claims 1 and 6 hereof, respectively.

According to another aspect of the invention there is provided a coded-data special reproduction method which reads out and decodes a unit group of intra-frame coded data, inter-frame forward predictive coded data and bidirectionally predictive coded data, then writes the decoded data into a frame buffer means and, after reading out the data from the frame buffer means, displays such data. The method comprises the steps of: continuously decoding portions of the intra-frame coded data and the inter-frame forward predictive coded data constituting the unit group read out, while intermittently decoding the remaining coded data; subsequently writing the decoded data in the frame buffer means; then reading out the data from the frame buffer means in the reverse order of the original pictures; and displaying the pictures thus read out.

In the coded-data special reproduction method mentioned above, some portion of the bidirectionally predictive coded data also may be decoded intermittently.

In decoding the unit group of data by the above method, priority may be granted to the intra-frame coded data and the inter-frame forward predictive coded data anterior to the intra-frame coded data appearing first in the unit data.

Further, the unit group of data may be composed of a block consisting of two or more unit data.

And when a picture to be displayed next has not yet been written in the frame buffer, the picture being displayed now may be continuously displayed.

According to a further aspect of the invention there is provided an apparatus capable of carrying out the above coded-data special reproduction method. This apparatus comprises: a buffer for storing read unit data

composed of intra-frame coded data, inter-frame forward predictive data and bidirectionally predictive coded data; a decoder for decoding the coded data obtained from the buffer; and a frame buffer for storing the respective coded data decoded by the decoder; wherein some portions of the intra-frame coded data, the inter-frame forward predictive coded data and the bidirectionally predictive coded data constituting the unit group are read out continuously from the buffer and are decoded, while the remaining portions of the data are read out intermittently therefrom and are decoded, and after the decoded data are written in the frame buffer, the data are read out from the frame buffer in the reverse order of the original pictures and then are displayed.

In the coded-data special reproduction apparatus mentioned above, some portion of the bidirectionally predictive coded data also may be decoded intermittently.

In decoding the unit group of data in the above apparatus, priority may be granted to the intra-frame coded data and the inter-frame forward predictive coded data anterior to the intra-frame coded data appearing first in the unit data.

Further, the unit group of data may be composed of a block consisting of two or more unit data.

And when a picture to be displayed next has not yet been written in the frame buffer, the picture being displayed now may be continuously displayed.

Thus, according to a preferred form of implementation of the invention as described below, some portions of I-picture and P-picture data constituting the unit group are continuously decoded at the time of special reproduction, while the remaining picture data are intermittently decoded and transferred to a display means, thereby reducing the number of required decoding steps. Consequently it becomes unnecessary to raise the data transfer rate to the decoder, hence eliminating failure in the data flow. Furthermore, the reproduced pictures can be displayed with reduction of the display delay time without the necessity of increasing the storage capacity of the frame buffer required for special reproduction.

The preferred form of implementation of the invention described hereinbelow provides a method of and an apparatus for special reproduction of coded data, wherein special reproduction in a reverse direction and so forth can be achieved to realize natural reproduced pictures on a display device without the necessity of either raising a coded-data transfer rate to a decoder or increasing the storage capacity of a frame memory.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a coded-data special reproduction apparatus according to an exemplary embodiment of the invention;

Figs. 2A and 2B show frame structures of group data;

Figs. 3A to 3E are timing charts of signals produced in an example of special reproduction;

Fig. 4 is a flow chart showing the operation performed in special reproduction;

Fig. 5 is a schematic table of an example in performing the special reproduction of Fig. 4;

Fig. 6 is a schematic table of an example in performing reverse reproduction with I- and P-pictures;

Fig. 7 is a schematic table of another example in performing reverse reproduction with I- and P-pictures;

Fig. 8 is a schematic table of an example in performing reverse reproduction with I-, P- and B-pictures;

Fig. 9 is a schematic table of another example in performing reverse reproduction with I- and P-pictures;

Fig. 10 is a schematic table of an example in performing reverse reproduction with entire I- and P-pictures;

Fig. 11 is a schematic table of another example in performing reverse reproduction with entire I- and P-pictures;

Fig. 12 is a schematic table of an example in performing reverse reproduction with approximately alternate I- and P-pictures;

Fig. 13 is a schematic table of another example in performing reverse reproduction with I- and P-pictures;

Fig. 14 is a schematic table of an example in performing reverse reproduction with I- and P-pictures while not displaying any same pictures in succession;

Figs. 15 to 19 are schematic tables of other examples in performing reverse reproduction with I- and P-pictures;

Fig. 20 is a schematic table of an example in performing reverse reproduction with entire I- and P-pictures and alternate B-pictures;

Fig. 21 is a schematic table of an example in performing reverse reproduction with entire I- and P-pictures and some B-pictures while not displaying any same pictures in succession;

Fig. 22 is a schematic table of an example in performing partial reverse reproduction with entire I-, P-and B-pictures;

Figs. 23 to 25 are schematic tables of an example in performing reverse reproduction with entire I-, P- and B pictures;

Figs. 26 to 28 are schematic tables of an example in performing reverse reproduction with approximately entire I-, P- and B-pictures;

Figs. 29 to 31 are schematic tables of another example in performing reverse reproduction with approximately entire I-, P- and B-pictures;

Fig. 32 is a block diagram showing the construction of an MPEG coder;

Figs. 33A and 33B show an inter-frame prediction

structure and a medium frame structure, respectively; and

Figs. 34A to 34E show the relationship among original pictures, coded pictures, on-medium pictures, decoded pictures and normal reproduced pictures.

Fig. 1 shows the constitution of an exemplary embodiment which represents a data special reproduction apparatus contrived for carrying out a coded-data special reproduction method embodying the invention, wherein a recording medium employed is a disk.

In this diagram, reference numeral 1 denotes a disk drive for reading out from the disk the coded data recorded through compression according to the MPEG standard. There are also shown a decoder 2 which consists of a code buffer 2-1, a decode processor 2-2 and a frame buffer 2-3 for decoding the data read out from the disk drive 1; a display device 3 for displaying the data decoded by the decoder 2; a controller 4 for controlling the decoder, by supplying control data to a specific data access means 5, in a manner to read out the specific data from the disk drive 1 and to obtain normal reproduced signal or special reproduced signal; and the specific data access means 5 for driving the disk drive 1 in a manner to read out the specific data from the disk under control of the controller 4.

Now an explanation will be given on the operation performed in a normal reproduction mode in the data special reproduction apparatus of the above constitution. On the disk, there are recorded I-, P- and B-pictures which are coded according to the MPEG standard in the format of Fig. 34C. In order to decode such recorded picture data in the order of Fig. 34D, specific picture data included in the video data is read out by the specific data access means 5 and then is supplied to and stored temporarily in the decode buffer 2-1 of the decoder 2. Subsequently the data thus stored in the code buffer 2-1 is read out therefrom and is decoded by the decode processor 2-2, so that the picture data are decoded in the order of Fig. 34D. And the decoded pictures are supplied to the frame buffer 2-3.

The frame buffer 2-3 has a memory capacity sufficient for storing three frames which are composed usually of an area 1, an area 2 and an area 3. And the decoded pictures supplied to the frame buffer 2-3 are stored in predetermined areas respectively.

Thereafter the pictures are read out from the frame buffer 2-3 in the order of Fig. 34E and then are visually represented on the display device 3, whereby the reproduced pictures are displayed in the order of the original ones.

Next the operation performed in a special reproduction mode will be described below with regard to an example of reverse reproduction. Since the MPEG2 standard includes both cases with and without the aforementioned GOP structure, a description will be given on an assumption that a plurality of MPEG-coded pictures constitute a unit of group data (GD).

Figs. 2A and 2B show an exemplary GD structure where one group data is composed of 15 pictures, in which n denotes a distance between an I-picture and a P-picture or a distance between P-pictures, and m denotes a distance between I-pictures.

More specifically, Fig. 2A shows an example of pictures arranged in four GD, and Fig. 2B shows actual bit streams rearranged on a recording medium in the decoding order in a normal reproduction mode.

Referring now to Figs. 3A to 3E, an explanation will be given on an exemplary data supply pattern supplied to the decoder and an exemplary data output pattern read out from the decoder and displayed when the MPEG-coded pictures thus arranged on the recording medium are reproduced in a reverse direction. In this case, it is supposed that the frame buffer 2-3 has areas sufficient for storing four pictures.

First in Fig. 3A, Dsync is a timing signal according to which the pictures read out from the disk drive 1 are written in the code buffer 2-1. This signal Dsync has a period of 2V corresponding to a double of a vertical synchronizing signal Vsync, i.e., a period of 1 frame. Therefore the code buffer 2-1 is triggered by the signal Dsync in such a manner that the pictures read out from the disk drive 1 are written in the period of 2V as shown in Fig. 3B. More specifically, under control of the specific data access means 5, pictures are read out from the disk drive 1 in the order of 16I, 19I, 22P, 25P, 28P, 27B, 16I, 19I, 24B, ... and so forth, as shown in Fig. 3B.

The pictures stored in the code buffer 2-1 are decoded by the decode process means 2-2 in such a manner that the decoding of each picture is completed within the period of 2V from the start thereof, and the decoded pictures are stored successively in the frame buffer 2-3, as shown in Fig. 3C.

More specifically, the I-picture 16I started to be decoded synchronously with timing tdI is decodable alone without reference to any other picture since it is an intraframe coded picture, and in synchronism with td2 of Dsync after a lapse of 2V therefrom, the data of the decoded I-picture 16I starts to be stored in the area 1 of the frame buffer 2-3.

Then in synchronism with timing td3 after a lapse of 2V therefrom, the P-picture 19P decoded with reference to the I-picture 16I starts to be stored in the area 2. Subsequently in synchronism with timing td3 after a lapse of 2V, the P-picture 22P decoded with reference to the P-picture 19P starts to be stored in the area 3; and next in synchronism with timing td5 after a lapse of 2V, the P-picture 25P decoded with reference to the P-picture 22P starts to be stored in the area 4. And further in synchronism with timing td6 after a lapse of 2V therefrom, the P-picture 28P decoded with reference to the P-picture 25P starts to be stored in the area 1 by overwriting.

Similarly, the B-picture 27B is decoded with reference to the P-picture 25P stored in the area 4 and also to the P-picture 28P stored in the area 1, and then starts to be stored in the area 2 synchronously with timing td7.

Subsequently the respective areas of the frame buffer 2-3 are overwritten successively as shown in Fig. 3C, whereby the decoded pictures are stored therein.

The decoded pictures thus stored in the frame buffer 2-3 are supplied to the display device 3 in a manner to be in the reverse order of the original pictures and are displayed thereon, but the timing to read out such decoded pictures from the frame buffer 2-3 conforms to the timing of the vertical synchronizing signal Vsync which is shown in Fig. 3D and has, as compared with the aforementioned signal Dsync, a deviation of 1 field corresponding to the period V of the vertical synchronizing signal.

For example, regarding the P-picture 28P started to be stored in the area 1 synchronously with timing td6 of Dsync, the data thereof starts to be transferred to the display device 3 synchronously with timing tvl of Vsync after a lapse of V from the timing td6. In this case, storage of the P-pictre 28P in the area 1 is completed latest synchronously with timing td7 after a lapse of 2V. However, since one field of the P-picture 28P can be transferred to the display device 3 at the time point td7, the data to be displayed can be transferred properly to the display device 3 without any failure.

As the data are read out from the disk driver 1 in the picture order of Fig. 3B and then are decoded, the data of the decoded pictures can be transferred to and displayed on the display device 3 in the order of Fig. 3C.

More specifically, the P-picture 28P starts to be transferred from the area 1 to the display device 3 synchronously with timing tv1 of Vsync; the B-picture 27B starts to be transferred from the area 2 to the display device 3 synchronously with timing tv2; the P-picture 25P starts to be transferred from the area 4 to the display device 3 synchronously with timing tv4; the B-picture 24B starts to be transferred from the area 2 to the display device 3 synchronously with timing tv5; and the P-picture 22P starts to be transferred from the area 3 to the display device 3 synchronously with timing tv7. Thereafter the B-picture 21B, P-picture 19P, B-picture 18B, I-picture 16I ... and so forth are transferred from the respective areas to the display device 3 in this order.

Consequently the video signals of the above P-picture 28P, B-picture 27B, P-picture 25P, B-picture 24B, P-picture 22P, B-picture 21B, P-picture 19P, B-picture 18B, I-picture 16I ... and so forth are displayed on the display device 3 in this order, whereby the pictures reproduced in the reverse direction can be visually represented on the display device 3.

Fig. 4 is a flow chart showing the operation of the controller 4 performed in this case.

When the operation is switched to a reverse reproduction mode, the routine of this flow chart is started. First at step S10, the data of pictures 16I, 19I, 22P and 25P are supplied to the decoder successively to be decoded therein, and the resultant decoded data are written respectively in the corresponding area 1, area 2, area 3 and area 4 of the frame buffer in the decoder. Next at step S20, the data of P-picture 28P is transferred to the decoder to be decoded therein, and the decoded data is written in the non-displayed area of the frame buffer. In selection of such write area, the controller previously stores divisions where pictures are not displayed, being displayed and already displayed respectively, then determines the picture reproducible by the least number of times of decoding operations when the data is once decoded, and overwrites that area. In this exemplary case, the area 1 with the I-picture 16I written therein is determined, and the decoded P-picture 28P is overwritten in the area 1.

Subsequently at step S30, the controller 4 controls the decoder 2 in such a manner as to start display of the P-picture 28P by triggering the same synchronously with Vsync after a lapse of 1V from the Vsync (Dsync) used to start decoding the P-picture 28P.

Next at step S40, the controller 4 executes its control action for reading out the data from the disk drive 1 so that the B-picture 27B can be decoded in synchronism with Vsync (Dsync) as a trigger after a lapse of 1V from the start of displaying the P-picture 28P, and also that the P-pictures 25P and 28P can be read out from the frame buffer 2-3 and be decoded.

Thereafter at step S50, the controller 4 controls the decoder 2 in a manner to start display of the B-picture 27B by triggering the same synchronously with Vsync after a lapse of 1V from the Dsync used to start decoding the B-picture 27B.

Further at step S60, the controller 4 executes its control action for enabling the decoder 2 to read out the data from the disk drive 1 and to decode the data so that the I-picture 16I can be decoded again in synchronism with Dsync as a trigger after a lapse of 1V from the start of displaying the B-picture 27B.

And finally at step S70, the controller 4 controls the decoder 2 to decode the data synchronously with the timing shown in Fig. 3.

Thus, in the coded-data reproduction apparatus described above, there exist data portions where, in a special reproduction mode, I- and P-pictures are decoded continuously, and data portions where such pictures are decoded intermittently. And B-pictures are decoded intermittently. The reason is based on that the controller 4 controls both the decoder 2 and the specific data access means 5 in such a manner as not to cause failure in the data flow without the necessity of raising the data transfer rate to the decoder 2.

In this case, decoding is performed with priority granted to the I-picture decodable alone and the P-picture decodable with reference merely to the immediately preceding I-picture or P-picture in the forward direction. And in case the next picture data to be supplied to the display device 3 is not stored in the frame buffer 2-3, the picture being displayed now is supplied continuously to the display device.

It is to be understood here that the data supply patterns of Figs. 3A to 3E in supplying the data to the de-

coder and the data output patterns thereof in reading out the data from the decoder and displaying such data are merely illustrative examples, and a variety of patterns are applicable in a special reproduction mode. Hereinafter various patterns adapted for special reproduction will be described, wherein the patterns shown in Figs. 3A to 3E are represented as Fig. 5.

In each of Figs. 5 through 31, a column "Code buffer read Dsync" includes the pictures read out from the code buffer 2-1 synchronously with the signal Dsync shown in Fig. 3A. A column "Frame buffer" is divided into fractional columns of numerals indicating the individual areas of the frame buffer 2-3, wherein there are included the pictures written in such areas synchronously with the signal Dsync as shown in Fig. 3C.

Meanwhile, a column "Display Vsync" includes the pictures read out from the frame buffer 2-3 synchronously with the signal Vsync shown in Fig. 3D and displayed on the display device 3.

Now each of Figs. 6 through 31 will be schematically described below.

Fig. 6 shows an example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 7 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 8 shows an example in performing reverse reproduction with I-, P- and B-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 9 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 10 shows an example in performing reverse reproduction with entire I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 11 shows another example in performing reverse reproduction with entire I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to four.

Fig. 12 shows an example in performing reverse reproduction with approximately alternate I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 13 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 14 shows an example in performing reverse reproduction with I- and P-pictures while not displaying any same pictures in succession, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to five.

Fig. 15 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 16 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 17 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 18 shows another example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to two.

Fig. 19 shows a further example in performing reverse reproduction with I- and P-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to two.

Fig. 20 shows an example in performing reverse reproduction with entire I- and P-pictures and alternate B-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Fig. 21 shows an example in performing reverse reproduction with entire I- and P-pictures and some B-pictures while not displaying any same pictures in succession, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to six.

Fig. 22 shows an example in performing partial reverse reproduction with successive I-, P- and B-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Figs. 23 to 25 show an example in performing reverse reproduction with entire I-, P- and B pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to four.

Figs. 26 to 28 show an example in performing reverse reproduction with approximately entire I-, P- and B-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

And Figs. 29 to 31 show another example in performing reverse reproduction with approximately entire I-, P- and B-pictures, wherein the number of storable frames (number of areas) in the frame buffer 2-3 is set to three.

Although the explanation given above is concerned with an exemplary case of coded data read out from recording media, the present invention is not limited thereto alone, and the coded data may be those stored via communication media or broadcasting media as well.

Thus, according to the above disclosure, some portions of I-picture and P-picture data constituting unit data are continuously decoded in a special reproduction mode, while the remaining picture data are intermittently decoded and transferred to a display means, thereby reducing the number of required decoding steps.

Consequently it becomes unnecessary to raise the

data transfer rate to the decoder, hence eliminating failure in the data flow.

Furthermore, the reproduced pictures can be displayed with reduction of the display delay time without the necessity of increasing the storage capacity of the frame buffer required for special reproduction.

Although the present invention has been described hereinabove with reference to some preferred embodiments thereof, it is to be understood that the invention is not limited to such embodiments alone, and it will be apparent to those skilled in the art that a variety of modifications and variations can be made without departing from the scope of the invention as determined by the terms of the appended claims.

Claims

1. A method of reproducing coded data formed into a predetermined unit group of frames composed of intra-frame coded data, forward predictive coded data and bidirectionally predictive coded data, said method comprising the steps of:

   supplying at least two consecutive coded data out of the intra-frame code data or the forward predictive coded data in said unit group;
   successively decoding the data thus supplied; and
   outputting the decoded data in the reverse order.

2. The method according to claim 1, further comprising the step of intermittently supplying the remaining forward predictive coded data.

3. The method according to claim 2, further comprising the step of intermittently supplying the bidirectionally predictive coded data.

4. The method according to claim 1, wherein said step of supplying the data comprises the steps of:

   reading, from a recording medium, at least two consecutive coded data out of the intra-frame coded data or the forward predictive coded data; and
   storing the coded data thus read out.

5. The method according to claim 4, wherein said step of outputting the data comprises the steps of:

   storing a plurality of frames of the decoded data; and
   reading out the stored data in the reverse order.

6. An apparatus for reproducing coded data formed into a predetermined unit group of frames composed of intra-frame coded data, forward predictive coded data and bidirectionally predictive coded data, said apparatus comprising:

   a means for supplying at least two consecutive coded data out of the intra-frame code data or the forward predictive coded data in said unit group;
   a means for successively decoding the data thus supplied; and
   a means for outputting the decoded data in the reverse order.

7. The apparatus according to claim 6, wherein said supply means also supplies the remaining forward predictive coded data intermittently.

8. The apparatus according to claim 7, wherein said supply means further supplies the bidirectionally predictive coded data intermittently.

9. The apparatus according to claim 8, wherein said supply means comprises: a reproduction means for reading, from a recording medium, at least two consecutive coded data out of the intra-frame coded data or the forward predictive coded data; and a first storage means for storing the coded data thus read out.

10. The apparatus according to claim 9, wherein said output means comprises: a second storage means for storing a plurality of frames of the decoded data; and a read means for reading out the stored data in the reverse order.

11. The apparatus according to claim 10, wherein said second storage means consists of at least three frame memories.

12. The apparatus according to claim 11, wherein said recording medium is an optical disk.

13. The apparatus according to claim 11, wherein said unit group is composed of fifteen frames.

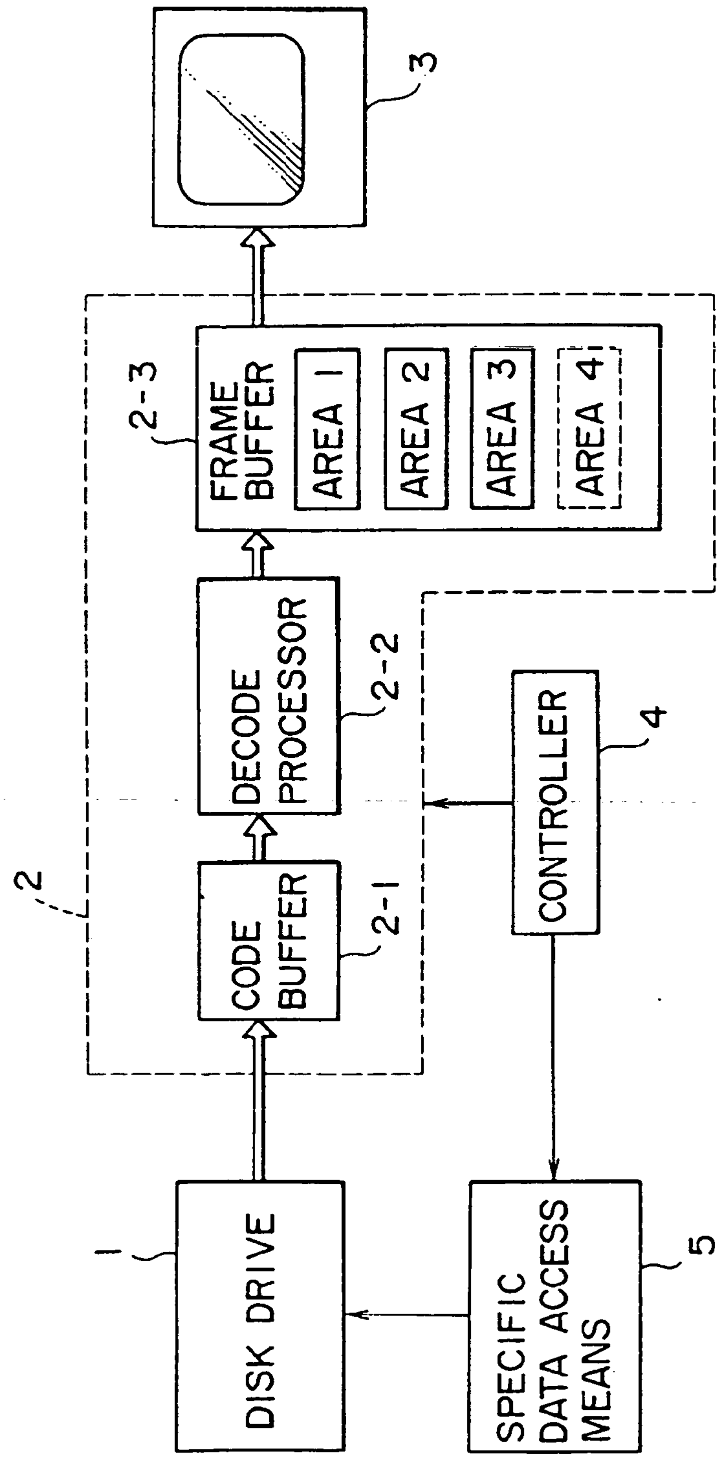
14. The apparatus according to claim 6, wherein said supply means supplies the entire intra-frame coded data and forward predictive coded data while supplying the bidirectionally predictive coded data intermittently.

15. The apparatus according to claim 6, wherein said supply means supplies the intra-frame coded data and one or more forward predictive coded data consecutive thereto.

16. The apparatus according to claim 15, wherein said read means reads out the same data a plurality of

times repeatedly.

F I G. 1



3
2-3
FRAME BUFFER
AREA 1
AREA 2
AREA 3
AREA 4
DECODE PROCESSOR
2-2
2
CODE BUFFER
2-1
CONTROLLER
4
1
DISK DRIVE
SPECIFIC DATA ACCESS MEANS
5

F I G. 2A

IGD = 15 PICTURES (n = 1, m = 15)

IGD

													-1B	0B
1I	2B	3B	4P	5B	6B	7P	8B	9B	10P	11B	12B	13P	14B	15B
16I	17B	18B	19P	20B	21B	22P	23B	24B	25P	26B	27B	28P	29B	30B
31I	32B	33B	34P											

F I G. 2B

1I	-1B	0B	4P	2B	3B	7P	5B	6B	10P	8B	9B	13P	11B	12B
16I	14B	15B	19P	17B	18B	22P	20B	21B	25P	23B	24B	28P	26B	27B
31I	29B	30B	34P	32B	33B									

ORDER ON ACTUAL BIT STREAM

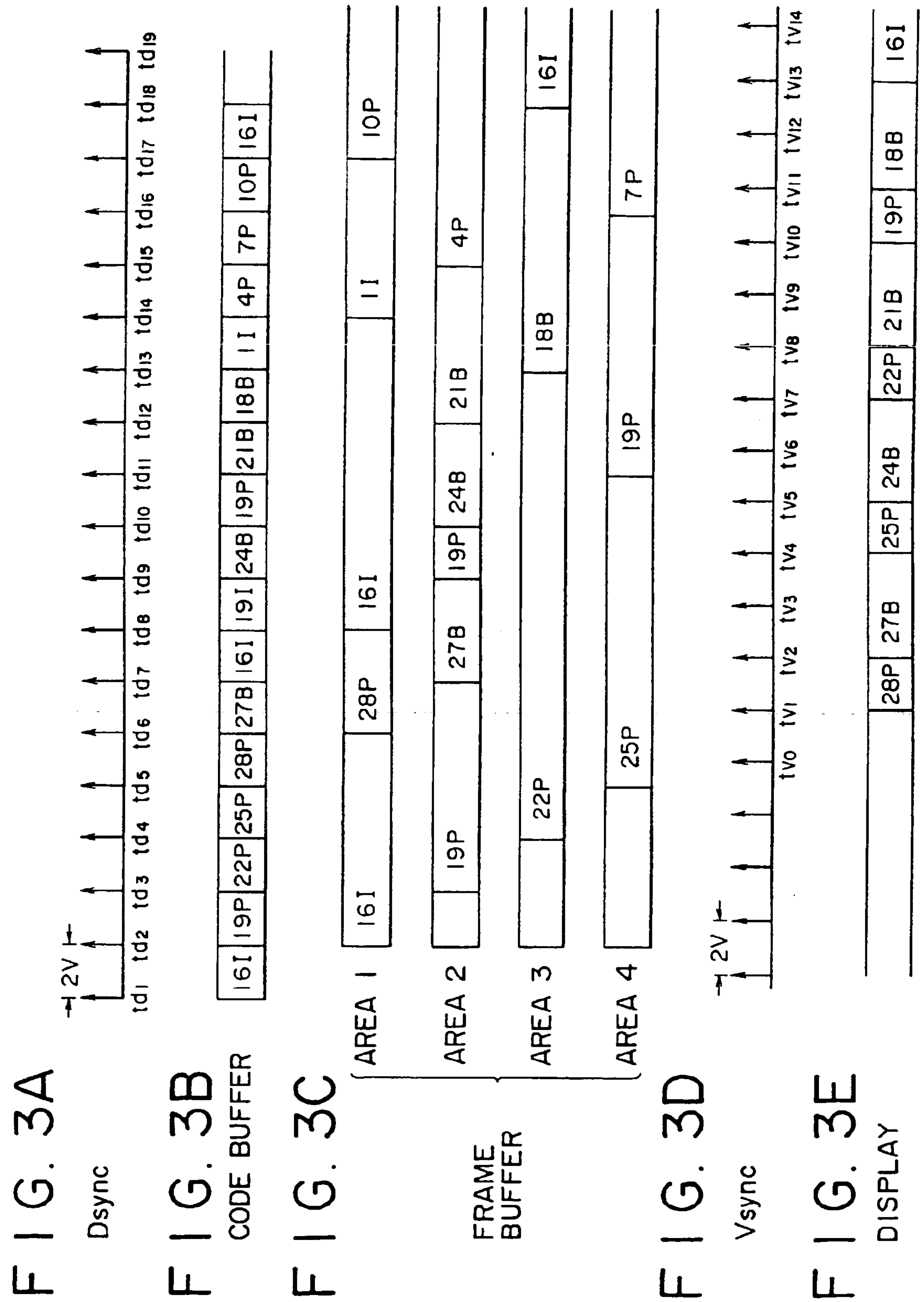


FIG. 3A
Dsync
2V
td1 td2 td3 td4 td5 td6 td7 td8 td9 td10 td11 td12 td13 td14 td15 td16 td17 td18 td19
FIG. 3B
CODE BUFFER
16I 19P 22P 25P 28P 27B 16I 19I 24B 19P 21B 18B 1I 4P 7P 10P 16I
FIG. 3C
FRAME BUFFER
AREA 1
16I 28P 16I 1I 10P
AREA 2
19P 27B 19P 24B 21B 4P
AREA 3
22P 18B 16I
AREA 4
25P 19P 7P
FIG. 3D
Vsync
2V
tV0 tV1 tV2 tV3 tV4 tV5 tV6 tV7 tV8 tV9 tV10 tV11 tV12 tV13 tV14
FIG. 3E
DISPLAY
28P 27B 25P 24B 22P 21B 19P 18B 16I

FIG. 4A

START

↓

DATA OF PICTURES 16I, 19P, 22P AND 25P ARE SUPPLIED TO DECODER SUCCESSIVELY TO BE DECODED, AND RESULTANT DECODED DATA ARE WRITTEN RESPECTIVELY IN AREAS 1, 2, 3 AND 4 OF FRAME BUFFER IN DECODER. — S10

↓

DATA OF PICTURE 28P IS TRANSFERRED TO DECODER TO BE DECODED, AND RESULTANT DECODED DATA IS WRITTEN IN AREA WHERE NON-DISPLAYED PICTURE DATA IS ALREADY WRITTEN.
IN SELECTION OF SUCH AREA, CONTROLLER PREVIOUSLY STORES DIVISIONS WHERE PICTURES ARE NOT DISPLAYED, BEING DISPLAYED AND ALREADY DISPLAYED RESPECTIVELY, AND THEN DETERMINES PICTURE REPRODUCIBLE BY LEAST NUMBER OF TIMES OF DECODING OPERATIONS WHEN DATA IS ONCE DECODED.
AFTER SUCH DETERMINATION, AREA OF PICTURE 16I IS OVERWRITTEN. — S20

↓

CONTROLLER 1 CONTROLS DECODER TO START DISPLAY OF PICTURE 28P BY TRIGGERING SAME SYNCHRONOUSLY WITH Vsync AFTER LAPSE OF 1V FROM Vsync (Dsync) USED TO START DECODING PICTURE 28P. — S30

↓

a

FIG. 4B

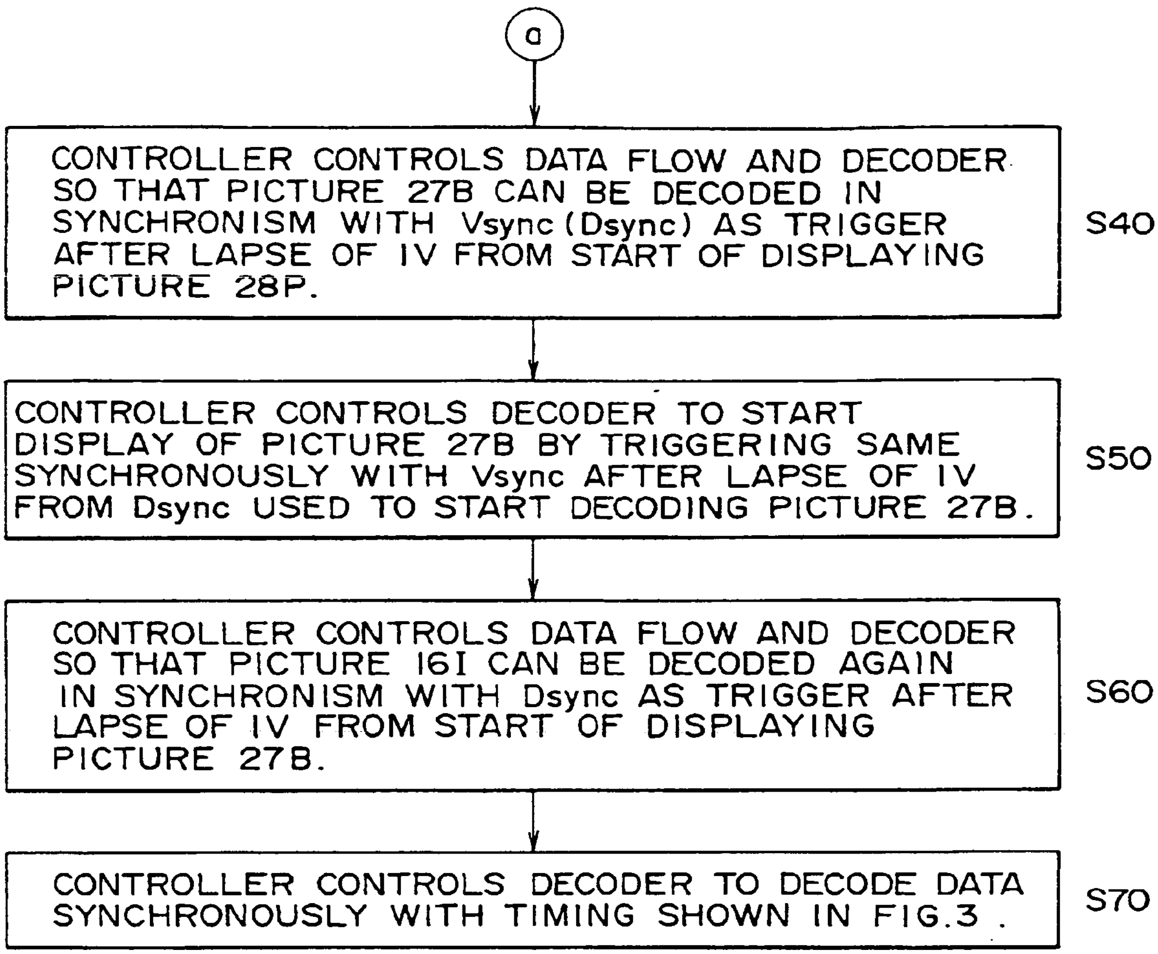

a
CONTROLLER CONTROLS DATA FLOW AND DECODER SO THAT PICTURE 27B CAN BE DECODED IN SYNCHRONISM WITH Vsync (Dsync) AS TRIGGER AFTER LAPSE OF 1V FROM START OF DISPLAYING PICTURE 28P.
S40
CONTROLLER CONTROLS DECODER TO START DISPLAY OF PICTURE 27B BY TRIGGERING SAME SYNCHRONOUSLY WITH Vsync AFTER LAPSE OF 1V FROM Dsync USED TO START DECODING PICTURE 27B.
S50
CONTROLLER CONTROLS DATA FLOW AND DECODER SO THAT PICTURE 16I CAN BE DECODED AGAIN IN SYNCHRONISM WITH Dsync AS TRIGGER AFTER LAPSE OF 1V FROM START OF DISPLAYING PICTURE 27B.
S60
CONTROLLER CONTROLS DECODER TO DECODE DATA SYNCHRONOUSLY WITH TIMING SHOWN IN FIG.3.
S70

FIG. 4

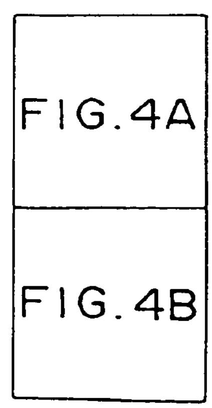


FIG.4A
FIG.4B

FIG. 5

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, 16I, 19P, 24B, 19P, 21B, 18B, 1I, 4P, 7P, 10P, 16I, 13P, –, · · ·

REPRODUCTION PATTERN :

28P, 27B, 27B, 25P, 24B, 24B, 22P, 21B, 21B, 19P, 18B, 18B, 16I, 16I, 16I, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
28P	16I	19P	22P	25P	
27B	28P	19P	22P	25P	
					28P
16I	28P	27B	22P	25P	
					27B
19P	16I	27B	22P	25P	
					27B
24B	16I	19P	22P	25P	
					25P
19P	16I	24B	22P	25P	
					24B
21B	16I	24B	22P	19P	
					24B
18B	16I	21B	22P	19P	
					22P
1I	16I	21B	18B	19P	
					21B
4P	1I	21B	18B	19P	
					21B
7P	1I	4P	18B	19P	
					19P
10P	1I	4P	18B	7P	
					18B
16I	10P	4P	18B	7P	
					18B
13P	10P	4P	16I	7P	
					16I
—	10P	4P	16I	13P	
					16I
7P	10P	4P	16I	13P	
					16I
—	10P	4P	7P	13P	
					13P
. . . .					

FIG. 6

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, — , — , — , -14I, -11P, -8P, — , · · ·

REPRODUCTION PATTERN :

22P, 22P, 19P, 19P, 16I, 16I, -8P, -8P, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I				
19P	16I			
22P	16I	19P		
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				19P
-14I	16I	19P	22P	
				19P
-11P	16I	19P	-14I	
				16I
-8P	16I	-11P	-14I	
				16I
—	-8P	-11P	-14I	
				-8P
· · · ·				

FIG. 7

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, — , 1I, 4P, — , 7P, — , -14I, -11P, ···

REPRODUCTION PATTERN :

22P, 22P, 19P, 16I, 16I, 7P, 7P, 4P, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
	16I	19P	22P	22P
1I	16I	19P	22P	22P
4P	16I	19P	1I	19P
—	16I	4P	1I	16I
7P	16I	4P	1I	16I
—	7P	4P	1I	7P
-14I	7P	4P	1I	7P
-11P	-14I	4P	1I	4P
....				

FIG. 8

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

19P, — , 18B, —, 1I, 4P, — , 3B, · · ·

REPRODUCTION PATTERN :

19P, 19P, 18B, 16I, 16I, 4P, 4P, 3B, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I				
19P	16I			
—	16I	19P		
				19P
18B	16I	19P		
				19P
—	16I	19P	18B	
				18B
1I	16I	19P	18B	
				16I
4P	16I	19P	1I	
				16I
—	16I	4P	1I	
				4P
3B	16I	4P	1I	
				4P
—	3B	4P	1I	
				3B
· · · · ·				

FIG. 9

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

25P, — , 1I, 4P, 7P, 10P, 1I, -14I, ···

REPRODUCTION PATTERN :

25P, 25P, 22P, 16I, 16I, 10P, 10P, 7P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
—	16I	25P	22P	
				25P
1I	16I	25P	22P	
				25P
4P	16I	1I	22P	
				22P
7P	16I	1I	4P	
				16I
10P	16I	4P	7P	
				16I
1I	16I	10P	7P	
				10P
-14I	1I	10P	7P	
				10P
-11P	1I	-14I	7P	
				7P
....				

F I G. 10

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, — , — , 16I, — , — , 19P, — , — , 1I, — , — , 4P, 7P, 10P, 13P, · · ·

REPRODUCTION PATTERN :

28P, 28P, 28P, 25P, 25P, 25P, 22P, 22P, 22P, 19P, 19P, 19P, 16I, 16I, 16I, 13P, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	25P	19P	22P	
—	25P	28P	22P	
				28P
—	25P	28P	22P	
				28P
16I	25P	28P	22P	
				28P
—	25P	16I	22P	
				25P
—	25P	16I	22P	
				25P
19P	25P	16I	22P	
				25P
—	19P	16I	22P	
				22P
—	19P	16I	22P	
				22P
1I	19P	16I	22P	
				22P
—	19P	16I	1I	
				19P
—	19P	16I	1I	
				19P
4P	19P	16I	1I	
				19P
7P	4P	16I	1I	
				16I
10P	4P	16I	7P	
				16I
13P	10P	16I	7P	
				16I
—	10P	13P	7P	
				13P
—	10P	13P	7P	
				13P
. . . .				

FIG. 11

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

28P, 19P, 1I, — , 4P, 7P, 10P, 13P, 4P, · · ·

REPRODUCTION PATTERN :

28P, 25P, 22P, 22P, 19P, 16I, 16I, 13P, 10P, 7P, 7P, 4P, 1I, 1I, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	FRAME BUFFER 4	DISPLAY Vsync
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
28P	16I	19P	22P		
19P	16I	28P	22P	25P	
					28P
1I	16I	19P	22P	25P	
					25P
—	16I	19P	22P	1I	
					22P
4P	16I	19P	22P	1I	
					22P
7P	16I	19P	4P	1I	
					19P
10P	16I	7P	4P	1I	
					16I
13P	16I	7P	10P	1I	
					16I
4P	13P	7P	10P	1I	
					13P
. . . .					

FIG. 12

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, — , 16I, 1I, 4P, 7P, 10P, 13P, — , 1I, ···

REPRODUCTION PATTERN :

28P, 28P, 22P, 22P, 16I, 16I, 16I, 13P, 13P, 7P, 7P, 1I, 1I, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	25P	19P	22P	
—	25P	28P	22P	28P
—	25P	28P	22P	28P
16I	25P	28P	22P	28P
1I	25P	16I	22P	22P
4P	1I	16I	22P	22P
7P	25P	16I	4P	16I
10P	7P	16I	4P	16I
13P	7P	16I	10P	16I
—	7P	13P	10P	13P
· · · ·				

FIG. 13

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, — , — , — , — , 1I, 4P, 7P, — , — , — , — , ···

REPRODUCTION PATTERN :

22P, 22P, 19P, 19P, 16I, 16I, 16I, 7P, 7P, 4P, 4P, 1I, 1I, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				19P
—	16I	19P	22P	
				19P
1I	16I	19P	22P	
				16I
4P	16I	19P	1I	
				16I
7P	16I	4P	1I	
				16I
—	7P	4P	1I	
				7P
.....				

FIG. 14

STORAGE CAPACITY OF FRAME BUFFER : 5 FRAMES

DATA SUPPLY PATTERN :

28P, 1I, 4P, 7P, 10P, 13P, -14I, -11P, ···

REPRODUCTION PATTERN :

28P, 25P, 22P, 19P, 16I, 13P, 10P, 7P, ···

CODE BUFFER READ Dsync	FRAME BUFFER					DISPLAY Vsync
	1	2	3	4	5	
16I						
19P	16I					
22P	16I	19P				
25P	16I	19P	22P			
28P	16I	19P	22P	25P		
1I	16I	19P	22P	25P	28P	
						28P
4P	16I	19P	22P	25P	1I	
						25P
7P	16I	19P	22P	4P	1I	
						22P
10P	16I	19P	7P	4P	1I	
						19P
13P	16I	10P	7P	4P	1I	
						16I
-14I	13P	10P	7P	4P	1I	
						13P
-11P	-14I	10P	7P	4P	1I	
						10P
23B	-14I	-11P	7P	4P	1I	
						7P
....						

FIG. 15

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

25P, — , 1I, 4P, 7P, 10P, — ,-14I, ···

REPRODUCTION PATTERN :

25P, 25P, 22P, 19P, 16I, 10P, 10P, 7P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	FRAME BUFFER 4	DISPLAY Vsync
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
—	16I	19P	22P	25P	
					25P
1I	16I	19P	22P	25P	
					25P
4P	16I	19P	22P	1I	
					22P
7P	16I	19P	22P	1I	
					19P
10P	16I	7P	4P	1I	
					16I
—	10P	7P	4P	1I	
					10P
-14I	10P	7P	4P	1I	
					10P
....					
					7P
....					

FIG. 16

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

25P, 1I, 4P, 7P, 10P, 1I, -14I, -11P, ···

REPRODUCTION PATTERN :

25P, 25P, 16I, 16I, 16I, 10P, 10P, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
1I	16I	19P	25P	
				25P
4P	16I	1I	25P	
				25P
7P	16I	1I	4P	
				16I
10P	16I	7P	4P	
				16I
1I	16I	7P	10P	
				16I
-14I	1I	7P	10P	
				10P
-11P	1I	-14I	10P	
				10P
-8P	1I	-14I	-11P	
				1I
....				

F I G. 17

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :
22P, 1I, 4P, 7P, -14I, -11P, -8P, · · ·

REPRODUCTION PATTERN :
22P, 19P, 16I, 7P, 4P, 1I, -8P, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
1I	16I	19P	22P	
				22P
4P	16I	19P	1I	
				19P
7P	16I	4P	1I	
				16I
-14I	7P	4P	1I	
				7P
. . . .				

FIG. 18

STORAGE CAPACITY OF FRAME BUFFER : 2 FRAMES

DATA SUPPLY PATTERN :

19P, − , 1I, 4P, − , −14P, −11P, · · ·

REPRODUCTION PATTERN :

19P, 16I, 16I, 4P, 1I, 1I, −11P, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER		DISPLAY Vsync
	1	2	
16I			
19P	16I		
—	16I	19P	
			19P
1I	16I	19P	
			16I
4P	16I	1I	
			16I
—	4P	1I	
			4P
. . . .			

FIG. 19

STORAGE CAPACITY OF FRAME BUFFER : 2 FRAMES

DATA SUPPLY PATTERN :
19P, 1I, 4P, -14P, -11P, ···

REPRODUCTION PATTERN :
19P, 16I, 4P, 1I, -11P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	DISPLAY Vsync
16I			
19P	16I		
1I	16I	19P	
			19P
4P	16I	1I	
			16I
-14I	4P	1I	
			4P
-13P	-14I	1I	
			1I
....			

F I G. 20

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, 16I, 19P, 22P, 24B, 16I, 19P, 21B, 16I, 18B, 1I, 4P, 7P, 10P, 13P, · · ·

REPRODUCTION PATTERN :

28P, 28P, 27B, 25P, 25P, 24B, 22P, 22P, 21B, 19P, 19P, 18B, 16I, 16I, 16I, 13P, · · ·

CODE BUFFER READ	FRAME BUFFER			DISPLAY
Dsync	1	2	3	Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	25P	19P	22P	
27B	25P	28P	22P	
				28P
16I	25P	28P	27B	
				28P
19P	25P	16I	27B	
				27B
22P	25P	16I	19P	
				25P
24B	25P	22P	19P	
				25P
16I	25P	22P	24B	
				24B
19P	16I	22P	24B	
				22P
21B	16I	22P	19P	
				22P
16I	21B	22P	19P	
				21B
18B	16I	22P	19P	
				19P
1I	16I	18B	19P	
				19P
4P	16I	18B	1I	
				18B
7P	16I	4P	1I	
				16I
10P	16I	4P	7P	
				16I
13P	16I	10P	7P	
				16I
—	13P	10P	7P	
				13P
—	13P	10P	7P	
				13P
· · · · ·				

F I G. 21

STORAGE CAPACITY OF FRAME BUFFER : 6 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, 1I, 4P, 7P, 18B, 10P, 13P, 12B, · · ·

REPRODUCTION PATTERN :

28P, 28P, 25P, 22P, 19P, 18B, 16I, 13P, 12B, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER						DISPLAY Vsync
	1	2	3	4	5	6	
16I							
19P	16I						
22P	16I	19P					
25P	16I	19P	22P				
28P	16I	19P	22P	25P			
27B	16I	19P	22P	25P	28P		
							28P
1I	16I	19P	22P	25P	28P	27B	
							27B
4P	16I	19P	22P	25P	1I	27B	
							25P
7P	16I	19P	22P	25P	1I	4P	
							22P
18B	16I	19I	22P	7P	1I	4P	
							19P
10P	16I	19P	18B	7P	1I	4P	
							18B
13P	16I	10P	18B	7P	1I	4P	
							16I
12B	16I	10P	13P	7P	1I	4P	
							13P
· · · ·							

FIG. 22

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

19P, — , 18B, 17B, — , — , 1I, 4P, — , 3B, 2B, — , · · ·

REPRODUCTION PATTERN :

19P, 19P, 18B, 17B, 16I, 16I, 16I, 4P, 4P, 3B, 2B, 1I, 1I, 1I, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I				
19P	16I			
—	16I	19P		19P
18B	16I	19P		19P
17B	16I	19P	18B	18B
—	16I	19P	17B	17B
—	16I	19P	17B	16I
1I	16I	19P	17B	16I
4P	16I	19P	1I	16I
—	16I	4P	1I	4P
. . . .				

FIG. 23

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

28P, — , 27B, — , 26B, — , — , 24B, — , — , 23B, — , 16I, 19P, 21B, — , 20B, — , — , 18B, 17B, 1I, 4P, 7P, 10P, 13P, 15B, — , 14B, — , 1I, 4P, 12B, — , 11B, 7P, 1I, — , · · ·

REPRODUCTION PATTERN :

28P, 28P, 27B, 27B, 26B, 26B, 25P, 25P, 24B, 24B, 23B, 23B, 22P, 22P, 21B, 21B, 20B, 20B, 19P, 19P, 18B, 18B, 17B, 17B, 16I, 16I, 15B, 15B, 14B, 14B, 13P, 13P, 12B, 12B, 11B, 11B, 10P, 10P, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	FRAME BUFFER 4	DISPLAY Vsync
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
28P	16I	19P	22P	25P	
—	16I	28P	22P	25P	28P
27B	16I	28P	22P	25P	28P
—	27B	28P	22P	25P	27B
26B	27B	28P	22P	25P	27B
—	26B	28P	22P	25P	26B
—	26B	28P	22P	25P	26B
24B	26B	28P	22P	25P	25P
—	24B	28P	22P	25P	25P
—	24B	28P	22P	25P	24B
23B	24B	28P	22P	25P	24B
—	23B	28P	22P	25P	23B
16I	23B	28P	22P	25P	23B
19P	23B	28P	22P	16I	22P
21B	19P	28P	22P	16I	22P
—	19P	21B	22P	16I	21B
20B	19P	21B	22P	16I	21B

FIG. 24

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
—	19P	20B	22P	16I	20B
—	19P	20B	22P	16I	20B
18B	19P	20B	22P	16I	19P
17B	19P	18B	22P	16I	19P
1I	19P	18B	17B	16I	18B
4P	1I	18B	17B	16I	18B
7P	1I	4P	17B	16I	17B
10P	7P	4P	17B	16I	17B
13P	7P	4P	10P	16I	16I
15B	7P	13P	10P	16I	16I
—	15B	13P	10P	16I	15B
14B	15B	13P	10P	16I	15B
—	14B	13P	10P	16I	14B
1I	14B	13P	10P	16I	14B
4P	1I	13P	10P	16I	13P
12B	1I	13P	10P	4P	13P
—	12B	13P	10P	4P	12B
11B	12B	13P	10P	4P	12B
7P	11B	13P	10P	4P	11B
1I	11B	7P	10P	4P	11B

FIG. 25

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
—	1 I	7 P	10 P	4 P	10 P
9 B	1 I	7 P	10 P	4 P	10 P
—	1 I	7 P	10 P	9 B	9 B
8 B	1 I	7 P	10 P	9 B	9 B
—	1 I	7 P	10 P	8 B	
....					

F I G. 26

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, – , – , 26B, – , 16I, 19P, 22P, 24B, 23B, 16I, 19P, – , 21B, – , 20B, – , 16I, – , 18B, – , 17B, 1I, 4P, 7P, 10P, 13P, – , – , – , – , 12B, ···

REPRODUCTION PATTERN :

28P, 28P, 27B, 27B, 26B, 26B, 25P, 25P, 25P, 24B, 23B, 23B, 22P, 22P, 21B, 21B, 20B, 20B, 19P, 19P, 18B, 18B, 17B, 17B, 16I, 16I, 16I, 13P, 13P, 13P, 13P, 13P, 12B, ···

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	16I	25P	22P	
27B	28P	25P	22P	
				28P
—	28P	25P	27B	
				28P
	28P	25P	27B	
				27B
26B	28P	25P	27B	
				27B
—	28P	25P	26B	
				26B
16I	28P	25P	26B	
				26B

FIG. 27

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
19P	16I	25P	26B	25P
22P	16I	25P	19P	25P
24B	22P	25P	19P	25P
23B	22P	25P	24B	24B
16I	22P	25P	23B	23B
19P	22P	16I	23B	23B
—	22P	16I	19P	22P
21B	22P	16I	19I	22P
—	22P	21B	19P	21B
20B	22P	21B	19P	21B
—	22P	20B	19P	20B
16I	22P	20B	19P	20B
—	16I	20B	19P	19P
18B	16I	20B	19P	19P
—	16I	18B	19P	18B
17B	16I	18B	19P	18B
1I	16I	17B	19P	17B
4P	16I	17B	1I	17B
7P	16I	4P	1I	16I
10P	16I	4P	7P	16I
13P	16I	10P	7P	16I
—	13P	10P	7P	13P

F I G. 28

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
—	13P	10P	7P	13P
—	13P	10P	7P	13P
—	13P	10P	7P	13P
12B	13P	10P	7P	13P
—	13P	10P	12B	12B
....				

F I G. 29

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, — , — , 26B, — , 16I, 19P, 22P, 24B, 23B, 16I, 19P, — , 21B, — , 20B, — , 16I, — , 18B, — , 1I, 4P, 7P, 10P, 13P, 14B, 1I, 4P, 7P, 10P, 12B, · · ·

REPRODUCTION PATTERN :

28P, 28P, 27B, 27B, 26B, 26B, 25P, 25P, 25P, 24B, 23B, 23B, 22P, 22P, 21B, 21B, 20B, 20B, 19P, 19P, 18B, 18B, 18B, 16I, 16I, 16I, 16I, 14B, 14B, 13P, 13P, 13P, 12B, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	16I	25P	22P	
27B	28P	25P	22P	
				28P
—	28P	25P	27B	
				28P
—	28P	25P	27B	
				27B
26B	28P	25P	27B	
				27B
—	28P	25P	26B	
				26B

FIG. 30

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I	28P	25P	26B	26B
19P	16I	25P	26B	25P
22P	16I	25P	19P	25P
24B	22P	25P	19P	25P
23B	22P	25P	24B	24B
16I	22P	25P	23B	23B
19P	22P	16I	23B	23B
—	22P	16I	19P	22P
21B	22P	16I	19I	22P
—	22P	21B	19P	21B
20B	22P	21B	19P	21B
—	22P	20B	19P	20B
16I	22P	20B	19P	20B
—	16I	20B	19P	19P
18B	16I	20B	19P	19P
—	16I	18B	19P	18B
1I	16I	18B	19P	18B
4P	16I	17B	1I	18B
7P	16I	4P	1I	16I
10P	16I	4P	7P	16I
13P	16I	10P	7P	16I
14B	16I	10P	13P	16I
1I	16I	14B	13P	14B

F I G. 31

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
4P	1I	14B	13P	14B
7P	1I	4P	13P	13P
10P	7P	4P	13P	13P
12B	7P	10P	13P	13P
—	12B	10P	13P	12B
....				

FIG. 32

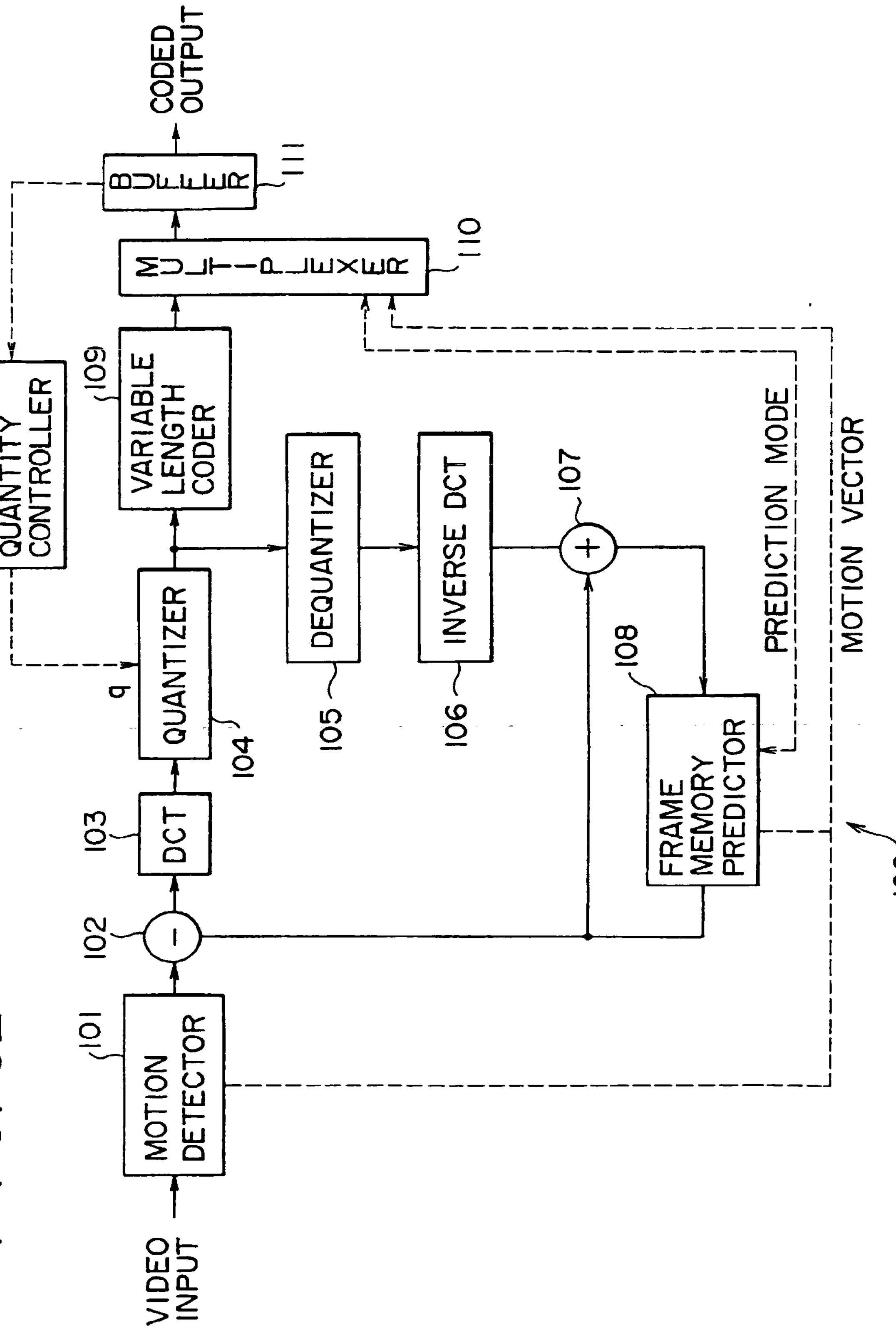
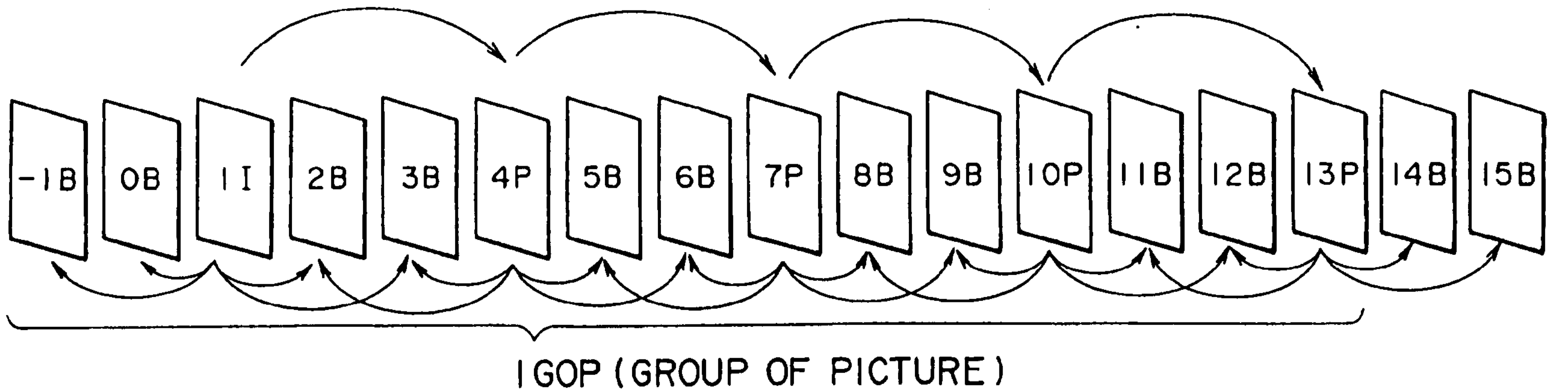
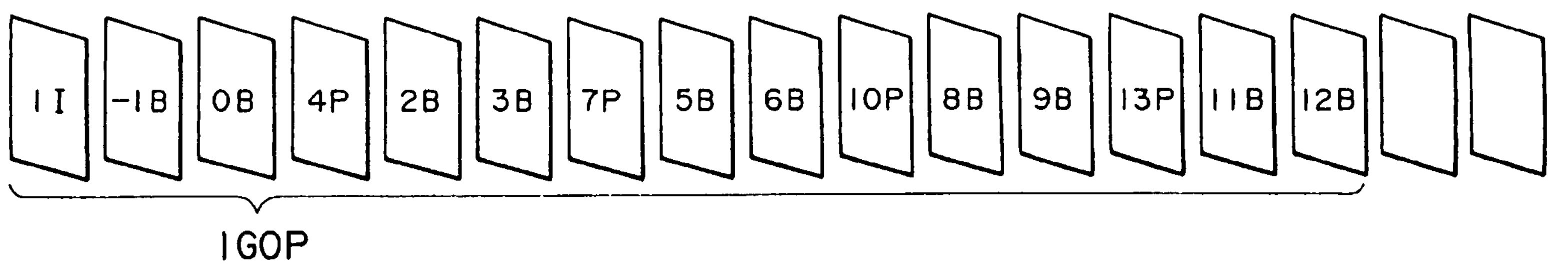

VIDEO INPUT
MOTION DETECTOR
101
102
DCT
103
QUANTIZER
104
q
CODE QUANTITY CONTROLLER
112
VARIABLE LENGTH CODER
109
MULTIPLEXER
110
BUFFER
111
CODED OUTPUT
DEQUANTIZER
105
INVERSE DCT
106
107
FRAME MEMORY PREDICTOR
108
PREDICTION MODE
MOTION VECTOR
100

FIG. 33A



STRUCTURE OF INTER-FRAME PREDICTION

FIG. 33B



STRUCTURE OF ON-MEDIUM FRAMES

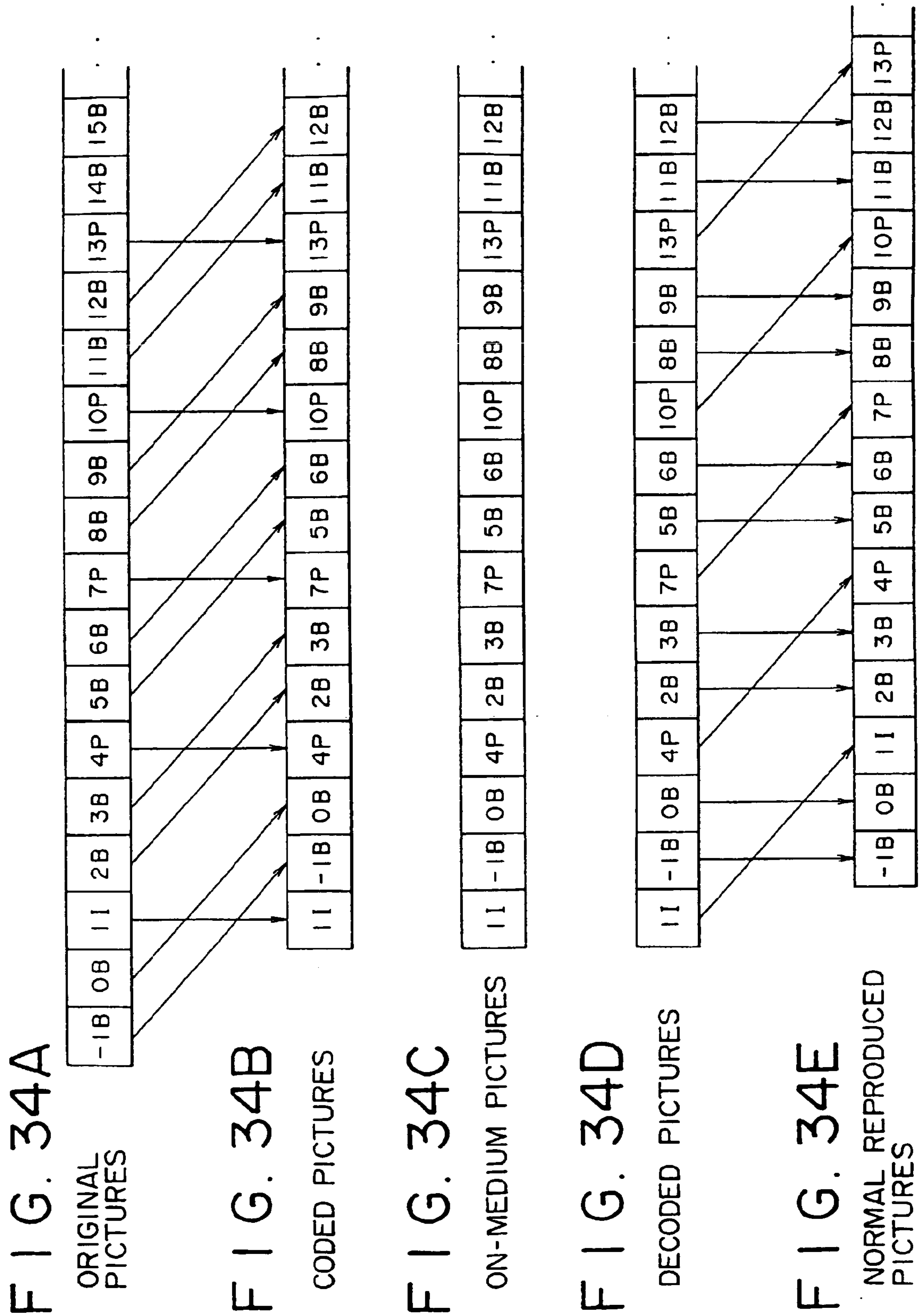


FIG. 34A ORIGINAL PICTURES

FIG. 34B CODED PICTURES

FIG. 34C ON-MEDIUM PICTURES

FIG. 34D DECODED PICTURES

FIG. 34E NORMAL REPRODUCED PICTURES

FIG. 1

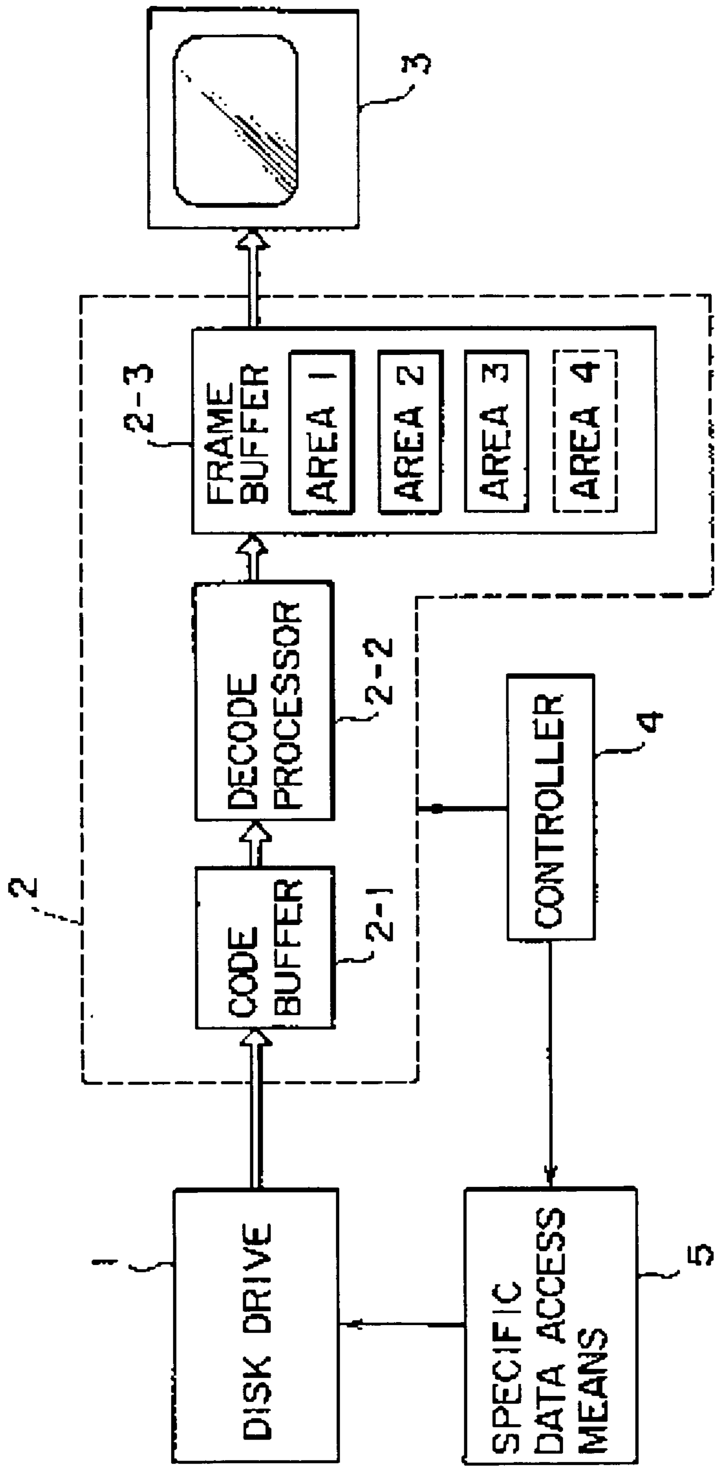

DISK DRIVE
1
SPECIFIC DATA ACCESS MEANS
5
CONTROLLER
4
2
CODE BUFFER
2-1
DECODE PROCESSOR
2-2
FRAME BUFFER
2-3
AREA 1
AREA 2
AREA 3
AREA 4
3

FIG. 2A

1GD = 15 PICTURES (n = 1, m = 15)

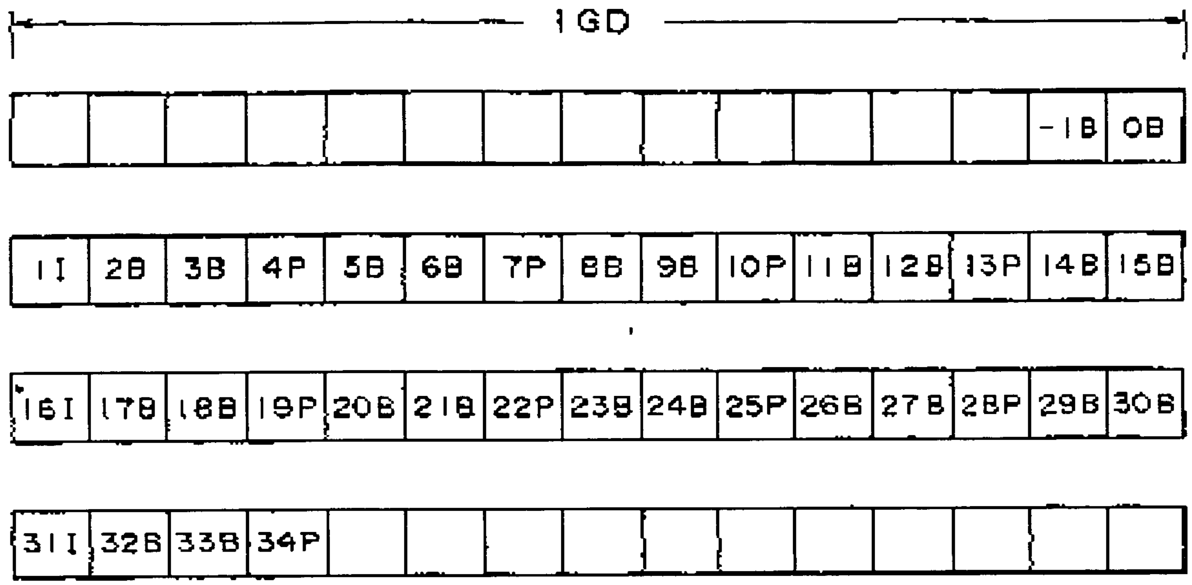
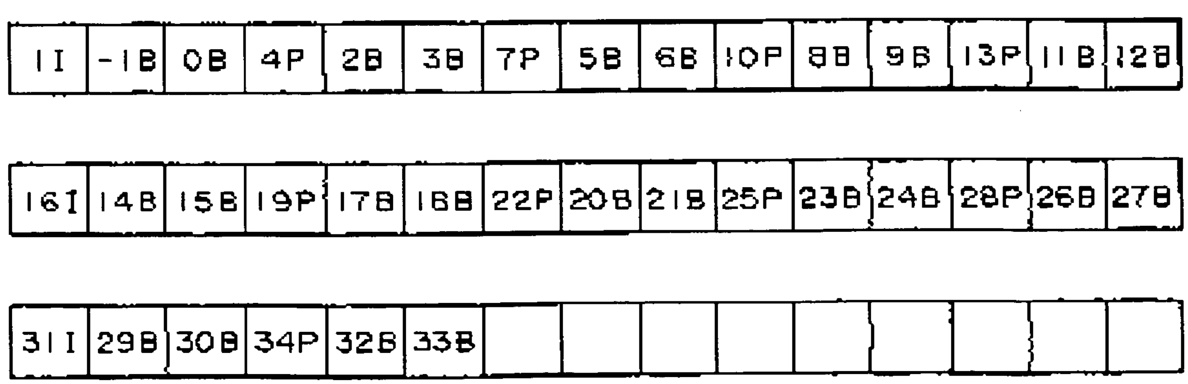


FIG. 2B



ORDER ON ACTUAL BIT STREAM

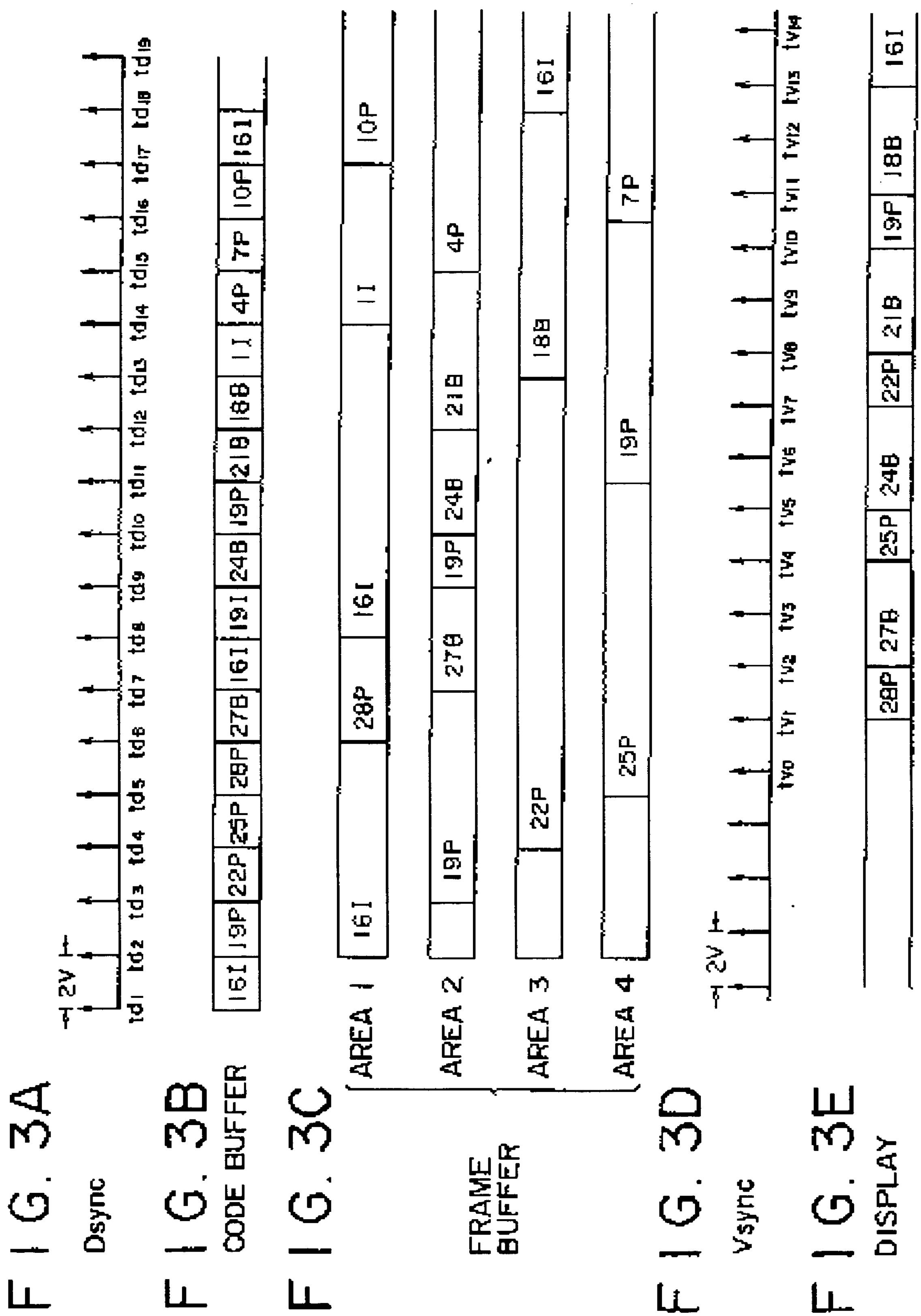


FIG. 3A
Dsync
2V
td1 td2 td3 td4 td5 td6 td7 td8 td9 td10 td11 td12 td13 td14 td15 td16 td17 td18 td19
FIG. 3B
CODE BUFFER
16I 19P 22P 25P 28P 27B 16I 19I 24B 19P 21B 18B 1I 4P 7P 10P 16I
FIG. 3C
FRAME BUFFER
AREA 1
16I 28P 16I 1I 10P
AREA 2
19P 27B 19P 24B 21B 4P
AREA 3
22P 18B 16I
AREA 4
25P 19P 7P
FIG. 3D
Vsync
2V
tv0 tv1 tv2 tv3 tv4 tv5 tv6 tv7 tv8 tv9 tv10 tv11 tv12 tv13 tv14
FIG. 3E
DISPLAY
28P 27B 25P 24B 22P 21B 19P 18B 16I

FIG. 4A

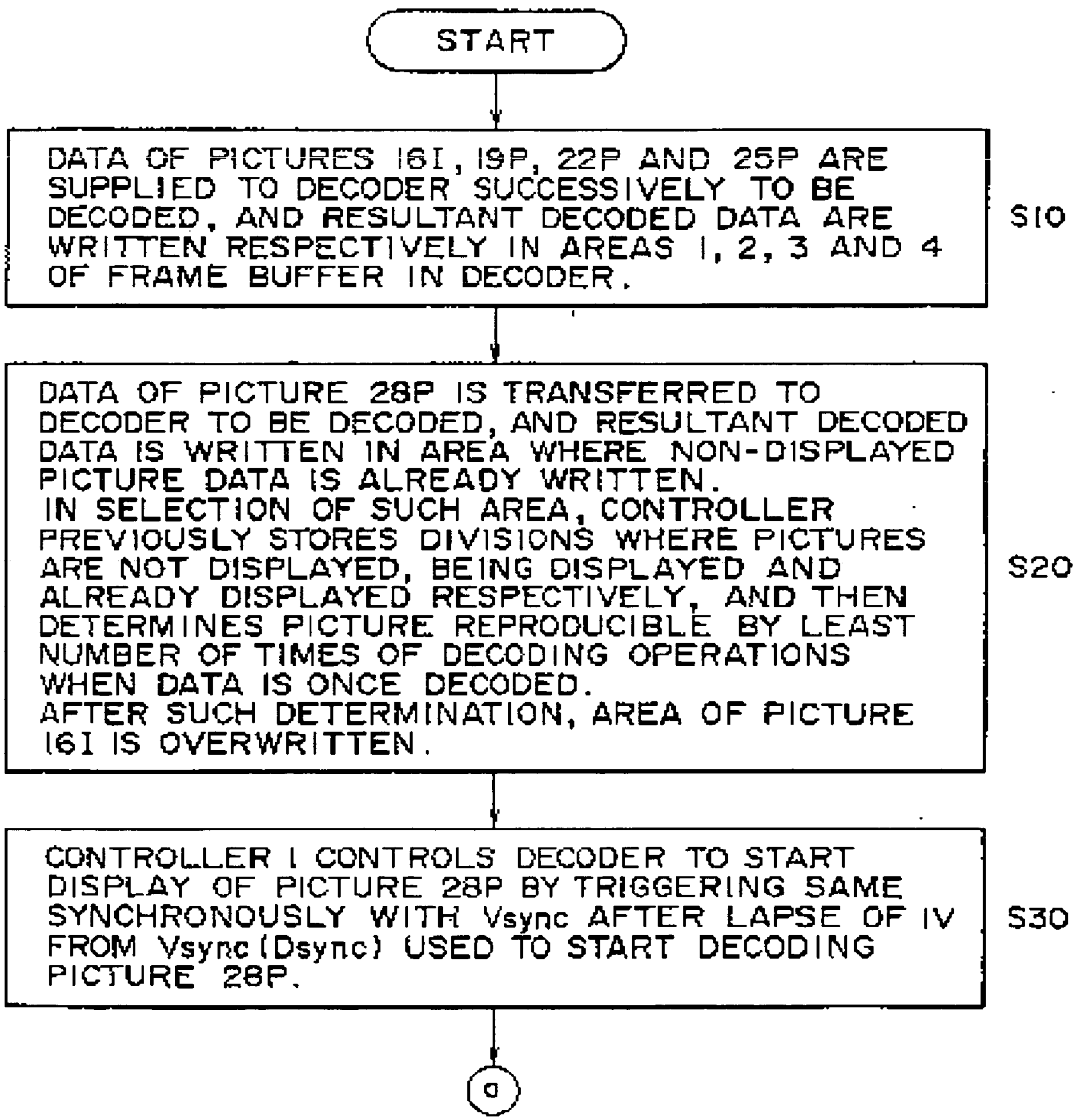

START
DATA OF PICTURES 16I, 19P, 22P AND 25P ARE SUPPLIED TO DECODER SUCCESSIVELY TO BE DECODED, AND RESULTANT DECODED DATA ARE WRITTEN RESPECTIVELY IN AREAS 1, 2, 3 AND 4 OF FRAME BUFFER IN DECODER.
S10
DATA OF PICTURE 28P IS TRANSFERRED TO DECODER TO BE DECODED, AND RESULTANT DECODED DATA IS WRITTEN IN AREA WHERE NON-DISPLAYED PICTURE DATA IS ALREADY WRITTEN.
IN SELECTION OF SUCH AREA, CONTROLLER PREVIOUSLY STORES DIVISIONS WHERE PICTURES ARE NOT DISPLAYED, BEING DISPLAYED AND ALREADY DISPLAYED RESPECTIVELY, AND THEN DETERMINES PICTURE REPRODUCIBLE BY LEAST NUMBER OF TIMES OF DECODING OPERATIONS WHEN DATA IS ONCE DECODED.
AFTER SUCH DETERMINATION, AREA OF PICTURE 16I IS OVERWRITTEN.
S20
CONTROLLER 1 CONTROLS DECODER TO START DISPLAY OF PICTURE 28P BY TRIGGERING SAME SYNCHRONOUSLY WITH Vsync AFTER LAPSE OF 1V FROM Vsync (Dsync) USED TO START DECODING PICTURE 28P.
S30
a

FIG. 4B

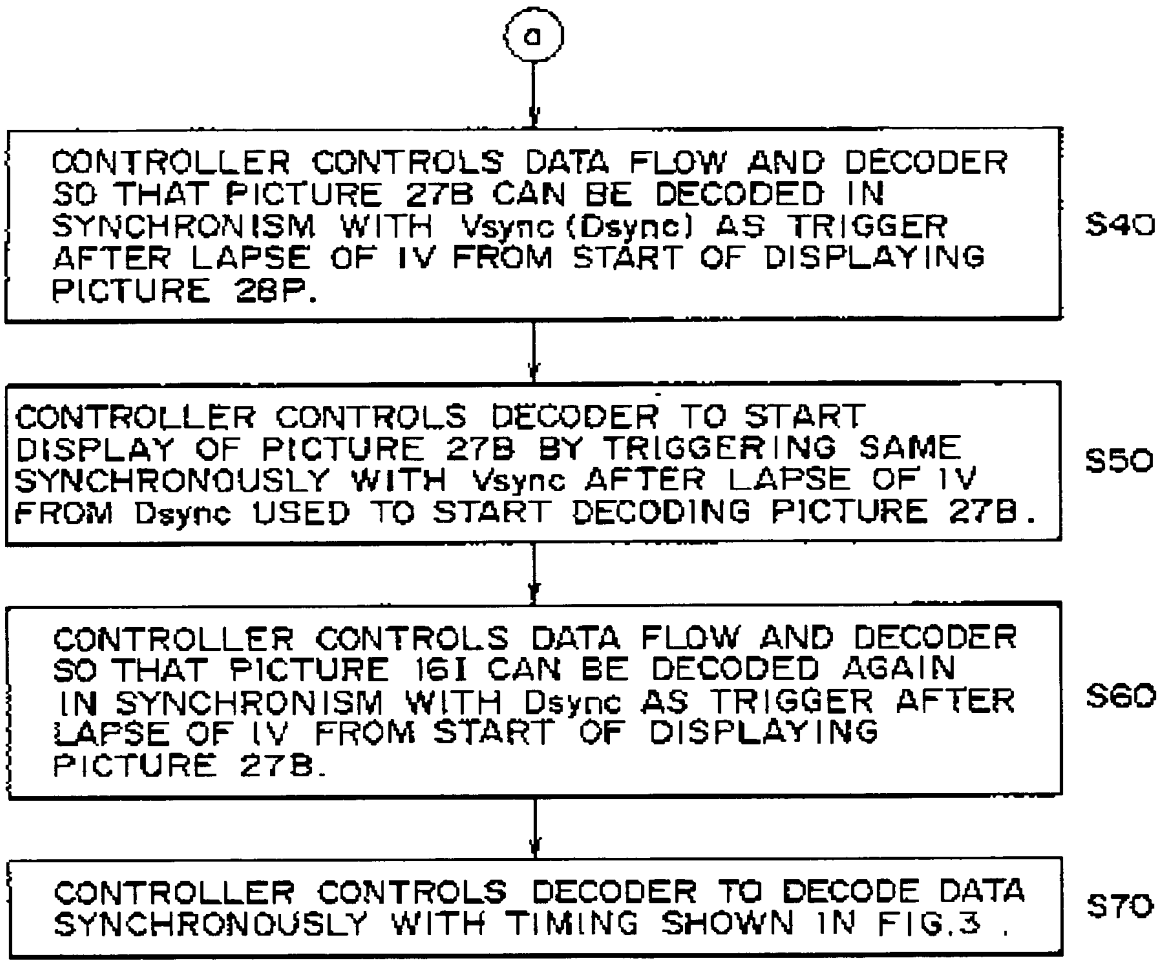

a
CONTROLLER CONTROLS DATA FLOW AND DECODER SO THAT PICTURE 27B CAN BE DECODED IN SYNCHRONISM WITH Vsync (Dsync) AS TRIGGER AFTER LAPSE OF 1V FROM START OF DISPLAYING PICTURE 28P.
S40
CONTROLLER CONTROLS DECODER TO START DISPLAY OF PICTURE 27B BY TRIGGERING SAME SYNCHRONOUSLY WITH Vsync AFTER LAPSE OF 1V FROM Dsync USED TO START DECODING PICTURE 27B.
S50
CONTROLLER CONTROLS DATA FLOW AND DECODER SO THAT PICTURE 16I CAN BE DECODED AGAIN IN SYNCHRONISM WITH Dsync AS TRIGGER AFTER LAPSE OF 1V FROM START OF DISPLAYING PICTURE 27B.
S60
CONTROLLER CONTROLS DECODER TO DECODE DATA SYNCHRONOUSLY WITH TIMING SHOWN IN FIG.3.
S70

FIG. 4

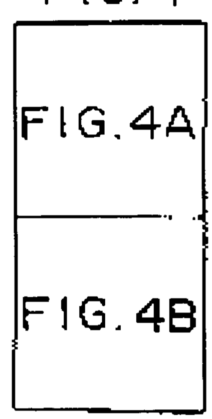


FIG.4A
FIG.4B

FIG. 5

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, 16I, 19P, 24B, 19P, 21B, 18B, 11I, 4P, 7P, 10P, 16I, 13P, -, ···

REPRODUCTION PATTERN :

28P, 27B, 27B, 25P, 24B, 24B, 22P, 21B, 21B, 19P, 18B, 18B, 16I, 16I, 16I, ···

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
28P	16I	19P	22P	25P	
27B	28P	19P	22P	25P	28P
16I	28P	27B	22P	25P	27B
19P	16I	27B	22P	25P	27B
24B	16I	19P	22P	25P	25P
19P	16I	24B	22P	25P	24B
21B	16I	24B	22P	19P	24B
18B	16I	21B	22P	19P	22P
11I	16I	21B	18B	19P	21B
4P	11I	21B	18B	19P	21B
7P	11I	4P	18B	19P	19P
10P	11I	4P	18B	7P	18B
16I	10P	4P	18B	7P	18B
13P	10P	4P	16I	7P	16I
—	10P	4P	16I	13P	16I
7P	10P	4P	16I	13P	16I
—	10P	4P	7P	13P	13P
....					

FIG. 6

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, —, —, —, -14I, -11P, -8P, —, ...

REPRODUCTION PATTERN :

22P, 22P, 19P, 19P, 16I, 16I, -8P, -8P, ...

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				19P
-14I	16I	19P	22P	
				19P
-11P	16I	19P	-14I	
				16I
-8P	16I	-11P	-14I	
				16I
—	-8P	-11P	-14I	
				-8P
...				

FIG. 7

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, — , 1I, 4P, — , 7P, — , -14I, -11P, ···

REPRODUCTION PATTERN :

22P, 22P, 19P, 16I, 16I, 7P, 7P, 4P, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
	16I	19P	22P	
				22P
1I	16I	19P	22P	
				22P
4P	16I	19P	1I	
				19P
—	16I	4P	1I	
				16I
7P	16I	4P	1I	
				16I
—	7P	4P	1I	
				7P
-14I	7P	4P	1I	
				7P
-11P	-14I	4P	1I	
				4P
....				

FIG. 8

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

19P, — , 18B, —, 1I, 4P, — , 3B, ···

REPRODUCTION PATTERN :

19P, 19P, 18B, 16I, 16I, 4P, 4P, 3B, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
—	16I	19P		
				19P
18B	16I	19P		
				19P
—	16I	19P	18B	
				18B
1I	16I	19P	18B	
				16I
4P	16I	19P	1I	
				16I
—	16I	4P	1I	
				4P
3B	16I	4P	1I	
				4P
—	3B	4P	1I	
				3B
....				

FIG. 9

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

25P, — , 1I, 4P, 7P, 10P, 1I, -14I, ···

REPRODUCTION PATTERN :

25P, 25P, 22P, 16I, 16I, 10P, 10P, 7P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
—	16I	25P	22P	25P
1I	16I	25P	22P	25P
4P	16I	1I	22P	22P
7P	16I	1I	4P	16I
10P	16I	4P	7P	16I
1I	16I	10P	7P	10P
-14I	1I	10P	7P	10P
-11P	1I	-14I	7P	7P
....				

FIG. 10

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, — , — , 16I, — , — , 19P, — , — , 1I, — , — , 4P, 7P, 10P, 13P, ···

REPRODUCTION PATTERN :

28P, 28P, 28P, 25P, 25P, 25P, 22P, 22P, 22P, 19P, 19P, 19P, 16I, 16I, 16I, 13P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	25P	19P	22P	
—	25P	28P	22P	28P
—	25P	28P	22P	28P
16I	25P	28P	22P	28P
—	25P	16I	22P	25P
—	25P	16I	22P	25P
19P	25P	16I	22P	25P
—	19P	16I	22P	22P
—	19P	16I	22P	22P
1I	19P	16I	22P	22P
—	19P	16I	1I	19P
—	19P	16I	1I	19P
4P	19P	16I	1I	19P
7P	4P	16I	1I	16I
10P	4P	16I	7P	16I
13P	10P	16I	7P	16I
—	10P	13P	7P	13P
—	10P	13P	7P	13P
·····				

FIG. 11

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

28P, 19P, 1I, — , 4P, 7P, 10P, 13P, 4P, ···

REPRODUCTION PATTERN :

28P, 25P, 22P, 22P, 19P, 16I, 16I, 13P, 10P, 7P, 7P, 4P, 1I, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
28P	16I	19P	22P		
19P	16I	28P	22P	25P	
					28P
1I	16I	19P	22P	25P	
					25P
—	16I	19P	22P	1I	
					22P
4P	16I	19P	22P	1I	
					22P
7P	16I	19P	4P	1I	
					19P
10P	16I	7P	4P	1I	
					16I
13P	16I	7P	10P	1I	
					16I
4P	13P	7P	10P	1I	
					13P
....					

FIG. 12

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, — , 16I, 1I, 4P, 7P, 10P, 13P, — , 1I, ···

REPRODUCTION PATTERN :

28P, 28P, 22P, 22P, 16I, 16I, 16I, 13P, 13P, 7P, 7P, 1I, 1I, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	25P	19P	22P	
—	25P	28P	22P	28P
—	25P	28P	22P	28P
16I	25P	28P	22P	28P
1I	25P	16I	22P	22P
4P	1I	16I	22P	22P
7P	25P	16I	4P	16I
10P	7P	16I	4P	16I
13P	7P	16I	10P	16I
—	7P	13P	10P	13P
. . . . .				

FIG. 13

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, — , — , — , — , 1I, 4P, 7P, — , — , — , — , ···

REPRODUCTION PATTERN :

22P, 22P, 19P, 19P, 16I, 16I, 16I, 7P, 7P, 4P, 4P, 1I, 1I, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				22P
—	16I	19P	22P	
				19P
—	16I	19P	22P	
				19P
1I	16I	19P	22P	
				16I
4P	16I	19P	1I	
				16I
7P	16I	4P	1I	
				16I
—	7P	4P	1I	
				7P
······				

FIG. 14

STORAGE CAPACITY OF FRAME BUFFER : 5 FRAMES

DATA SUPPLY PATTERN :

28P, 1I, 4P, 7P, 10P, 13P, -14I, -11P, ···

REPRODUCTION PATTERN :

28P, 25P, 22P, 19P, 16I, 13P, 10P, 7P, ···

CODE BUFFER READ Dsync	FRAME BUFFER					DISPLAY Vsync
	1	2	3	4	5	
16I						
19P	16I					
22P	16I	19P				
25P	16I	19P	22P			
28P	16I	19P	22P	25P		
1I	16I	19P	22P	25P	28P	
4P	16I	19P	22P	25P	1I	28P
7P	16I	19P	22P	4P	1I	25P
10P	16I	19P	7P	4P	1I	22P
13P	16I	10P	7P	4P	1I	19P
-14I	13P	10P	7P	4P	1I	16I
-11P	-14I	10P	7P	4P	1I	13P
23B	-14I	-11P	7P	4P	1I	10P
·····						7P

FIG. 15

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

25P, — , 1I, 4P, 7P, 10P, — , -14I, ···

REPRODUCTION PATTERN :

25P, 25P, 22P, 19P, 16I, 10P, 10P, 7P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	FRAME BUFFER 4	DISPLAY Vsync
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
—	16I	19P	22P	25P	
1I	16I	19P	22P	25P	25P
4P	16I	19P	22P	1I	25P
7P	16I	19P	22P	1I	22P
10P	16I	7P	4P	1I	19P
—	10P	7P	4P	1I	16I
-14I	10P	7P	4P	1I	10P
....					10P
....					7P

FIG. 16

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

25P, 1I, 4P, 7P, 10P, 1I, -14I, -11P, ···

REPRODUCTION PATTERN :

25P, 25P, 16I, 16I, 16I, 10P, 10P, 1I, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
1I	16I	19P	25P	
				25P
4P	16I	1I	25P	
				25P
7P	16I	1I	4P	
				16I
10P	16I	7P	4P	
				16I
1I	16I	7P	10P	
				16I
-14I	1I	7P	10P	
				10P
-11P	1I	-14I	10P	
				10P
-8P	1I	-14I	-11P	
				1I
····				

FIG. 17

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

22P, 1I, 4P, 7P, -14I, -11P, -8P, ···

REPRODUCTION PATTERN :

22P, 19P, 16I, 7P, 4P, 1I, -8P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
1I	16I	19P	22P	
				22P
4P	16I	19P	1I	
				19P
7P	16I	4P	1I	
				16I
-14I	7P	4P	1I	
				7P
....				

FIG. 18

STORAGE CAPACITY OF FRAME BUFFER : 2 FRAMES

DATA SUPPLY PATTERN :

19P, — , 1I, 4P, — , -14P, -11P, ···

REPRODUCTION PATTERN :

19P, 16I, 16I, 4P, 1I, 1I, -11P, ···

CODE BUFFER READ Dsync	FRAME BUFFER		DISPLAY Vsync
	1	2	
16I			
19P	16I		
—	16I	19P	
			19P
1I	16I	19P	
			16I
4P	16I	1I	
			16I
—	4P	1I	
			4P
....			

FIG. 19

STORAGE CAPACITY OF FRAME BUFFER : 2 FRAMES

DATA SUPPLY PATTERN :

19P, 1I, 4P, -14P, -11P, ···

REPRODUCTION PATTERN :

19P, 16I, 4P, 1I, -11P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	DISPLAY Vsync
16I			
19P	16I		
1I	16I	19P	
			19P
4P	16I	1I	
			16I
-14I	4P	1I	
			4P
-13P	-14I	1I	
			1I
....			

F I G. 20

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, 16I, 19P, 22P, 24B, 16I, 19P, 21B, 16I, 18B, 1I, 4P, 7P, 10P, 13P, ···

REPRODUCTION PATTERN :

28P, 28P, 27B, 25P, 25P, 24B, 22P, 22P, 21B, 19P, 19P, 18B, 16I, 16I, 16I, 13P, ···

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	25P	19P	22P	
27B	25P	28P	22P	28P
16I	25P	28P	27B	28P
19P	25P	16I	27B	27B
22P	25P	16I	19P	25P
24B	25P	22P	19P	25P
16I	25P	22P	24B	24B
19P	16I	22P	24B	22P
21B	16I	22P	19P	22P
16I	21B	22P	19P	21B
18B	16I	22P	19P	19P
1I	16I	18B	19P	19P
4P	16I	18B	1I	18B
7P	16I	4P	1I	16I
10P	16I	4P	7P	16I
13P	16I	10P	7P	16I
—	13P	10P	7P	13P
—	13P	10P	7P	13P
....				

FIG. 21

STORAGE CAPACITY OF FRAME BUFFER : 6 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, 1I, 4P, 7P, 18B, 10P, 13P, 12B, · · ·

REPRODUCTION PATTERN :

28P, 28P, 25P, 22P, 19P, 18B, 16I, 13P, 12B, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER						DISPLAY Vsync
	1	2	3	4	5	6	
16I							
19P	16I						
22P	16I	19P					
25P	16I	19P	22P				
28P	16I	19P	22P	25P			
27B	16I	19P	22P	25P	28P		
1I	16I	19P	22P	25P	28P	27B	28P
4P	16I	19P	22P	25P	1I	27B	27B
7P	16I	19P	22P	25P	1I	4P	25P
18B	16I	19I	22P	7P	1I	4P	22P
10P	16I	19P	18B	7P	1I	4P	19P
13P	16I	10P	18B	7P	1I	4P	18B
12B	16I	10P	13P	7P	1I	4P	16I
· · · ·							13P

F I G. 22

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

19P, — , 18B, 17B, — , — , 1I, 4P, — , 3B, 2B, — , · · ·

REPRODUCTION PATTERN :

19P, 19P, 18B, 17B, 16I, 16I, 16I, 4P, 4P, 3B, 2B, 1I, 1I, 1I, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
—	16I	19P		19P
18B	16I	19P		19P
17B	16I	19P	18B	18B
—	16I	19P	17B	17B
—	16I	19P	17B	16I
1I	16I	19P	17B	16I
4P	16I	19P	1I	16I
—	16I	4P	1I	4P
· · · ·				

F I G. 23

STORAGE CAPACITY OF FRAME BUFFER : 4 FRAMES

DATA SUPPLY PATTERN :

28P, — , 27B, — , 26B, — , — , 24B, — , — , 23B, — , 16I, 19P, 21B, — , 20B, — , — , 18B, 17B, 1I, 4P, 7P, 10P, 13P, 15B, — , 14B, — , 1I, 4P, 12B, — , 11B, 7P, 1I, — , · · ·

REPRODUCTION PATTERN :

28P, 28P, 27B, 27B, 26B, 26B, 25P, 25P, 24B, 24B, 23B, 23B, 22P, 22P, 21B, 21B, 20B, 20B, 19P, 19P, 18B, 18B, 17B, 17B, 16I, 16I, 15B, 15B, 14B, 14B, 13P, 13P, 12B, 12B, 11B, 11B, 10P, 10P, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	FRAME BUFFER 4	DISPLAY Vsync
16I					
19P	16I				
22P	16I	19P			
25P	16I	19P	22P		
28P	16I	19P	22P	25P	
—	16I	28P	22P	25P	
					28P
27B	16I	28P	22P	25P	
					28P
—	27B	28P	22P	25P	
					27B
26B	27B	28P	22P	25P	
					27B
—	26B	28P	22P	25P	
					26B
—	26B	28P	22P	25P	
					26B
24B	26B	28P	22P	25P	
					25P
—	24B	28P	22P	25P	
					25P
—	24B	28P	22P	25P	
					24B
23B	24B	28P	22P	25P	
					24B
—	23B	28P	22P	25P	
					23B
16I	23B	28P	22P	25P	
					23B
19P	23B	28P	22P	16I	
					22P
21B	19P	28P	22P	16I	
					22P
—	19P	21B	22P	16I	
					21B
20B	19P	21B	22P	16I	
					21B

FIG. 24

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
—	19P	20B	22P	16I	20B
—	19P	20B	22P	16I	20B
18B	19P	20B	22P	16I	19P
17B	19P	18B	22P	16I	19P
1I	19P	18B	17B	16I	18B
4P	1I	18B	17B	16I	18B
7P	1I	4P	17B	16I	17B
10P	7P	4P	17B	16I	17B
13P	7P	4P	10P	16I	16I
15B	7P	13P	10P	16I	16I
—	15B	13P	10P	16I	15B
14B	15B	13P	10P	16I	15B
—	14B	13P	10P	16I	14B
1I	14B	13P	10P	16I	14B
4P	1I	13P	10P	16I	13P
12B	1I	13P	10P	4P	13P
—	12B	13P	10P	4P	12B
11B	12B	13P	10P	4P	12B
7P	11B	13P	10P	4P	11B
1I	11B	7P	10P	4P	11B

F I G. 25

CODE BUFFER READ Dsync	FRAME BUFFER				DISPLAY Vsync
	1	2	3	4	
—	1 I	7 P	10 P	4 P	10 P
9 B	1 I	7 P	10 P	4 P	10 P
—	1 I	7 P	10 P	9 B	9 B
8 B	1 I	7 P	10 P	9 B	9 B
—	1 I	7 P	10 P	8 B	
. . . . .					

FIG. 26

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, — , — , 26B, — , 16I, 19P, 22P, 24B, 23B, 16I, 19P, — , 21B, — , 20B, — , 16I, — , 18B, — , 17B, 1I, 4P, 7P, 10P, 13P, — , — , — , — , 12B, · · ·

REPRODUCTION PATTERN :

28P, 28P, 27B, 27B, 26B, 26B, 25P, 25P, 25P, 24B, 23B, 23B, 22P, 22P, 21B, 21B, 20B, 20B, 19P, 19P, 18B, 18B, 17B, 17B, 16I, 16I, 16I, 13P, 13P, 13P, 13P, 13P, 12B, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	16I	25P	22P	
27B	28P	25P	22P	
				28P
—	28P	25P	27B	
				28P
	28P	25P	27B	
				27B
26B	28P	25P	27B	
				27B
—	28P	25P	26B	
				26B
16I	28P	25P	26B	
				26B

FIG. 27

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
19P	16I	25P	26B	25P
22P	16I	25P	19P	25P
24B	22P	25P	19P	25P
23B	22P	25P	24B	24B
16I	22P	25P	23B	23B
19P	22P	16I	23B	23B
—	22P	16I	19P	22P
21B	22P	16I	19I	22P
—	22P	21B	19P	21B
20B	22P	21B	19P	21B
—	22P	20B	19P	20B
16I	22P	20B	19P	20B
—	16I	20B	19P	19P
18B	16I	20B	19P	19P
—	16I	18B	19P	18B
17B	16I	18B	19P	18B
1I	16I	17B	19P	17B
4P	16I	17B	1I	17B
7P	16I	4P	1I	16I
10P	16I	4P	7P	16I
13P	16I	10P	7P	16I
—	13P	10P	7P	13P

FIG. 28

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
—	13P	10P	7P	13P
—	13P	10P	7P	13P
—	13P	10P	7P	13P
12B	13P	10P	7P	13P
—	13P	10P	12B	12B
....				

F I G. 29

STORAGE CAPACITY OF FRAME BUFFER : 3 FRAMES

DATA SUPPLY PATTERN :

28P, 27B, — , — , 26B, — , 16I, 19P, 22P, 24B, 23B, 16I, 19P, — , 21B, — , 20B, — , 16I, — , 18B, — , 1I, 4P, 7P, 10P, 13P, 14B, 1I, 4P, 7P, 10P, 12B, · · ·

REPRODUCTION PATTERN :

28P, 28P, 27B, 27B, 26B, 26B, 25P, 25P, 25P, 24B, 23B, 23B, 22P, 22P, 21B, 21B, 20B, 20B, 19P, 19P, 18B, 16B, 18B, 16I, 16I, 16I, 16I, 14B, 14B, 13P, 13P, 13P, 12B, · · ·

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I				
19P	16I			
22P	16I	19P		
25P	16I	19P	22P	
28P	16I	25P	22P	
27B	28P	25P	22P	
				28P
—	28P	25P	27B	
				28P
—	28P	25P	27B	
				27B
26B	28P	25P	27B	
				27B
—	28P	25P	26B	
				26B

FIG. 30

CODE BUFFER READ Dsync	FRAME BUFFER			DISPLAY Vsync
	1	2	3	
16I	28P	25P	26B	26B
19P	16I	25P	26B	25P
22P	16I	25P	19P	25P
24B	22P	25P	19P	25P
23B	22P	25P	24B	24B
16I	22P	25P	23B	23B
19P	22P	16I	23B	23B
—	22P	16I	19P	22P
21B	22P	16I	19I	22P
—	22P	21B	19P	21B
20B	22P	21B	19P	21B
—	22P	20B	19P	20B
16I	22P	20B	19P	20B
—	16I	20B	19P	19P
18B	16I	20B	19P	19P
—	16I	18B	19P	18B
1I	16I	16B	19P	18B
4P	16I	17B	1I	18B
7P	16I	4P	1I	16I
10P	16I	4P	7P	16I
13P	16I	10P	7P	16I
14B	16I	10P	13P	16I
1I	16I	14B	13P	14B

FIG. 31

CODE BUFFER READ Dsync	FRAME BUFFER 1	FRAME BUFFER 2	FRAME BUFFER 3	DISPLAY Vsync
4P	1I	14B	13P	14B
7P	1I	4P	13P	13P
10P	7P	4P	13P	13P
12B	7P	10P	13P	13P
—	12B	10P	13P	12B
....				

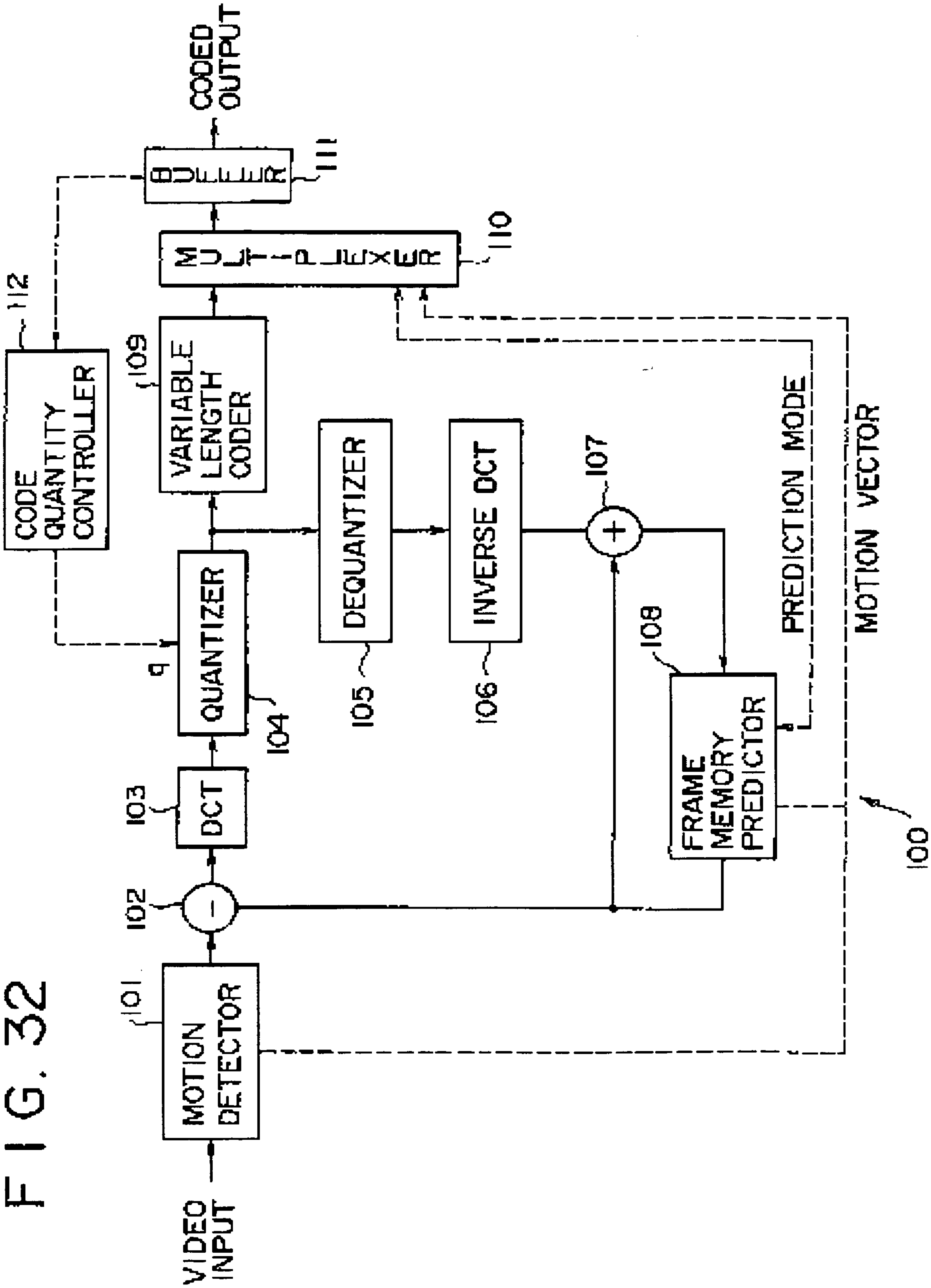
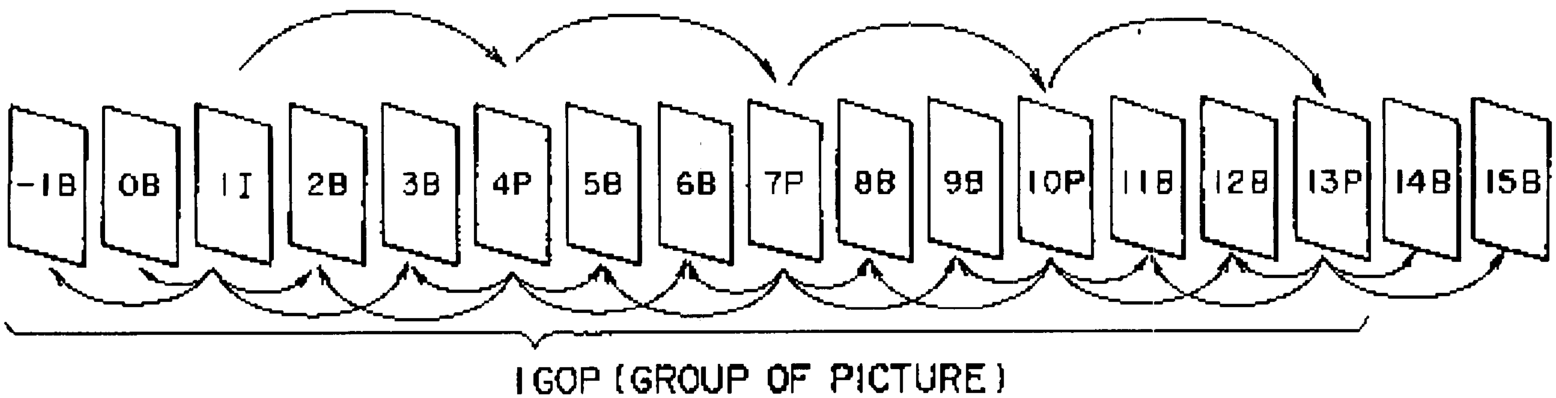

VIDEO INPUT
MOTION DETECTOR
101
102
DCT
103
QUANTIZER
104
q
CODE QUANTITY CONTROLLER
112
VARIABLE LENGTH CODER
109
MULTIPLEXER
110
BUFFER
111
CODED OUTPUT
DEQUANTIZER
105
INVERSE DCT
106
107
FRAME MEMORY PREDICTOR
108
PREDICTION MODE
MOTION VECTOR
100

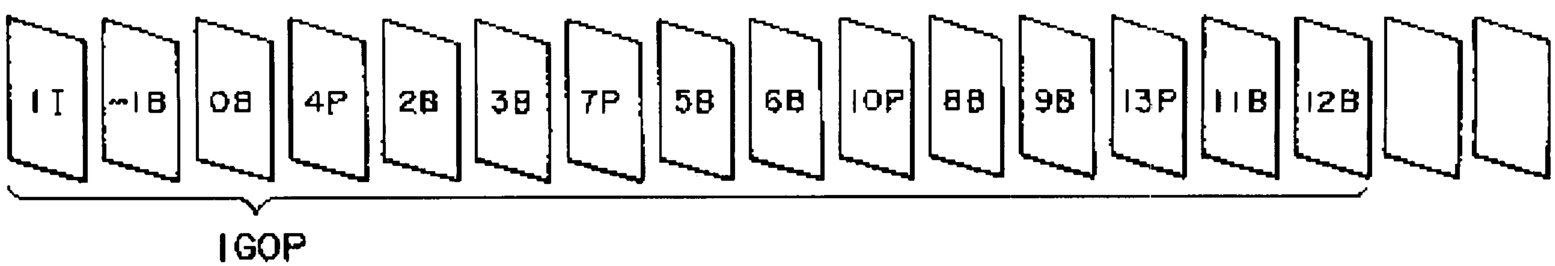
FIG. 32

FIG. 33A



STRUCTURE OF INTER-FRAME PREDICTION

FIG. 33B



STRUCTURE OF ON-MEDIUM FRAMES

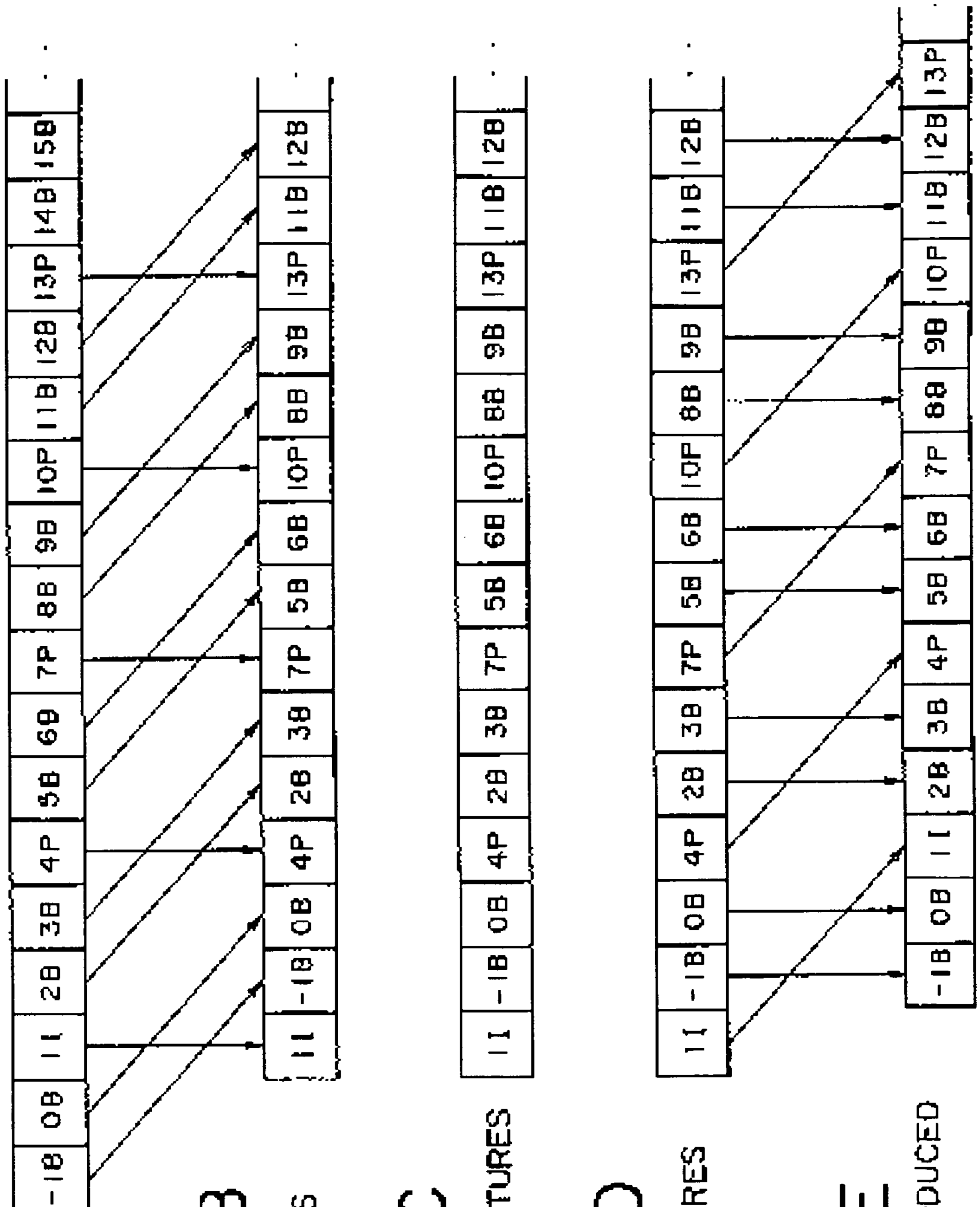


FIG. 34A ORIGINAL PICTURES

FIG. 34B CODED PICTURES

FIG. 34C ON-MEDIUM PICTURES

FIG. 34D DECODED PICTURES

FIG. 34E NORMAL REPRODUCED PICTURES

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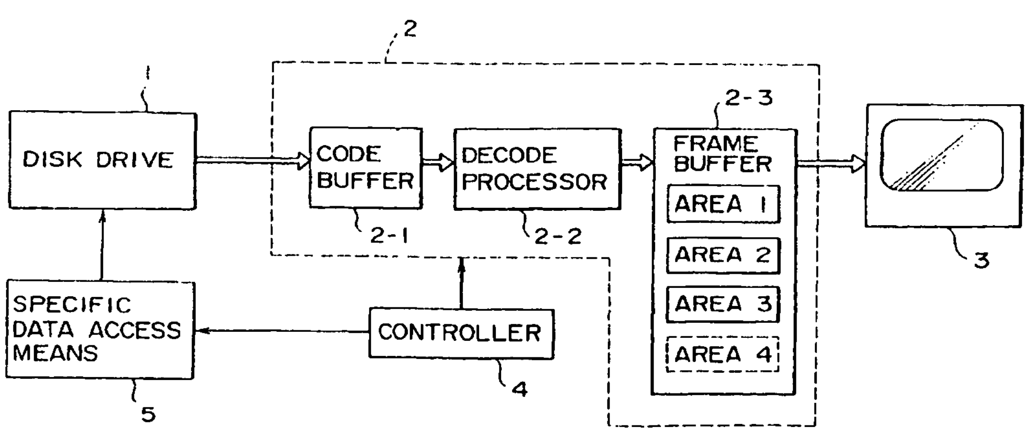
(54) Reproduction of coded data

(57) A coded-data special reproduction method reads out and decodes unit group data composed of intra-frame coded data, inter-frame forward predictive coded data and bidirectionally predictive coded data, writes the decoded data into a frame buffer (2-3) and, after reading out the data therefrom, displays (3) such data. The method comprises the steps of continuously decoding portions of the intra-frame coded data and the inter-frame forward predictive coded data constituting the unit group data read out, while intermittently decoding the remaining coded data; writing the decoded data in the frame buffer (2-3); reading out the data therefrom in a reverse order of the original pictures; and displaying the pictures (3) thus read out. An apparatus designed to carry out the above method comprises a buffer (2-1) for storing the group data; a decoder (2-2) for decoding the coded data obtained from the buffer; and a frame buffer (2-3) for storing the respective coded data decoded by the decoder. Special reverse reproduction of the coded data can be achieved to realize natural reproduced pictures on a display device (3) without the necessity of raising the coded-data transfer rate to the decoder (2-2) or increasing the storage capacity of the frame buffer (2-3).

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 96 30 0980

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 545 323 A (SONY CORPORATION) * column 4, line 15 - column 9, line 50; figures 1-3 *	1,4-6,15	H04N9/877 H04N5/783
Y		16	
A	---	9-14	
Y	F. PEREIRA ET AL: "A CCITT Compatible Coding Algorithm for Digital Recording of Moving Images." SIGNAL PROCESSING. IMAGE COMMUNICATION., vol. 2, no. 2, August 1990, AMSTERDAM NL, pages 155-169, XP000243475 * page 156, column 1, line 32 - page 160, column 2, line 34; figures 1-3 * -----	16	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 November 1997	Verleye, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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